# WSDOT Design Manual Chapter Revision

**To: Design Manual Points of Contact (POCs)**

**Subj: Design Manual Chapter Revision Review**

**Chapter Title: 1320 – Roundabouts**

**HQ Chapter Lead: Ted Focke**

**Reason for Revision: To reduce PE efforts related to roundabout analysis, documentation, and approvals. Additional change calls for using the WB-67 design vehicle for roundabout design on state routes and updating capacity analysis software.**

**HQ Policy Review Comments Deadline: Oct. 2, 2009**

**Instructions to Points of Contact (POCs):**

This cover form accompanies the chapter revision for the requested policy review.

**It is crucial to engage those in your region who have a stake in this topic. Step 2 below applies to them.**

1. Please distribute this chapter to those in your region who have a stake in the outcomes of this policy revision.
2. **Reviewers:** *Type your changes directly in the word document and your insertions and deletions will show up as tracked changes. Then send your comments back to your POC.*
3. Compile your region's review edits & comments into one document, resolving any regional differences.
4. Complete the appropriate check boxes below, including:
   - Indicate your WSDOT entity: region / area / HQ Org
   - Select the "supportability" box that aligns with your entity's opinions
5. E-mail the completed review document, **with this form**, back to the Chapter Lead in the HQ Design Office prior to, or by, the comment deadline.

**Select your region / area:**

_X_ Eastern __ North Central __ South Central X Southwest _X_ Olympic

_X_ Baker __ SnoKing __ AWV _X_ FHWA X Other (please specify): HQ Design

**Our entity has reviewed this revision and we:**

__Support the changes as is (we made no changes during our review)

_X Support the changes as we have modified them in the attached

_X Support the changes if our comments are addressed to our satifaction

as we have modified them in the attached

_X Support the changes as we have modified them in the attached

_X Support the changes as ~~we~~ have WRITTEN AND ~~modified them in the attached~~SUGGESTED BY OTHER OFFICES

__ Cannot support this policy revision because (please be specific):

**From:** Tevis, John
**Sent:** Tuesday, September 15, 2009 11:17 AM
**To:** Focke, Ted
**Subject:** RE: Chapter 1320, Roundabouts policy Review

Good point…

Well anyway Exhibits 1320-23 and 1320-21 are different and one or the other needs to be changed.
I would like to talk about it in a policy meeting. What do you think?

**JOHN TEVIS**
SWR | NWR Design Liaison Engineer
HQ Design Office 2B25 (360) 705-7460

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**From:** Focke, Ted
**Sent:** Monday, September 14, 2009 3:18 PM
**To:** Tevis, John
**Subject:** RE: Chapter 1320, Roundabouts policy Review

The sight distance is to give the driver a better opportunity to see a pedestrian starting to cross the roadway and yield as required by the RCWs. I believe that when prudent drivers see pedestrians descending a curb ramp they will know that they intend to cross the roadway. By providing the sight distance, we allow drives to obey the law, but they can still chose not to.

*Ted Focke PE*
Geometric Engineer
(360) 705-7270
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focket@WSDOT.WA.GOV

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**From:** Tevis, John
**Sent:** Monday, September 14, 2009 12:49 PM
**To:** Focke, Ted
**Subject:** RE: Chapter 1320, Roundabouts policy Review

Assuming that drivers are to yield to pedestrians waiting to cross. And, assuming we wouldn't make someone wait on a ramp. How will drivers know that pedestrians are waiting to cross if we design the roadway such that the drivers can't see them in time to stop?

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**From:** Focke, Ted
**Sent:** Monday, September 14, 2009 12:28 PM
**To:** Tevis, John
**Subject:** RE: Chapter 1320, Roundabouts policy Review

Decision Sight Distance is not mandatory when it is not feasible to provide it. Stopping sight distance is the minimum with out a deviation.

At a non-roundabout intersection, the 6 ft may not reach the curb. However, at a roundabout the shoulder is eliminated; therefore, the 6 ft should include most of the ramp. This may not help a pedestrian that darts into traffic, but it should give 1 to 2 extra seconds of view for pedestrians traveling at a moderate to brisk pace.

*Ted Focke PE*
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**From:** Tevis, John
**Sent:** Monday, September 14, 2009 11:01 AM
**To:** Focke, Ted
**Subject:** RE: Chapter 1320, Roundabouts policy Review

Ted,

I don't think we should use 1320.06(3)(h) for roundabouts or intersection and below is why:

- As you once said "Decision Sight Distance" is desired not mandatory OR is the way it is stated here makes "Decision Sight Distance" mandatory?
- What if the "6 feet from the edge of traveled way" is the ramp of a curb ramp? There will be no one for the driver to see until it's too late.
- It says, "stopping sight distance may be provided". Does this mean that stopping sight distance is the bare minimum? Stopping Sight Distance is what the roundabout guidance talks about so this makes sense.

I think because the landings are where pedestrians are expected to wait for traffic, sight distance triangles needed to include landings which could very well be outside of the "6 feet from the edge of traveled way".

If we decide to adhere to the "6 feet from the edge of traveled way" we need to dimension the roundabout guidance. It won't look good.

**JOHN TEVIS**
SWR | NWR Design Liaison Engineer
HQ Design Office 2B25 (360) 705-7460

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**From:** Focke, Ted

**Sent:** Monday, September 14, 2009 9:28 AM
**To:** Tevis, John
**Cc:** Lippincott, Greg; Sielbach, Kurt
**Subject:** RE: Chapter 1320, Roundabouts policy Review

Exhibit 1320-23 is closer to correct that 1320-21. Chapter 1310 specifies that the sight distance be provided to the crosswalk and 6 ft from the edge of traveled way. See 1310.05(6).

For consistency with Ch 1310 the following should be added to 1320.06(3)(h):

> "Provide drivers approaching crosswalks decision sight distance to an area the width of the crosswalk and 6 feet from the edge of traveled way. Where decision sight distance is not feasible, stopping sight distance may be provided. (See Chapter 1260 for guidance on decision and stopping sight distances.)"

*Ted Focke PE*
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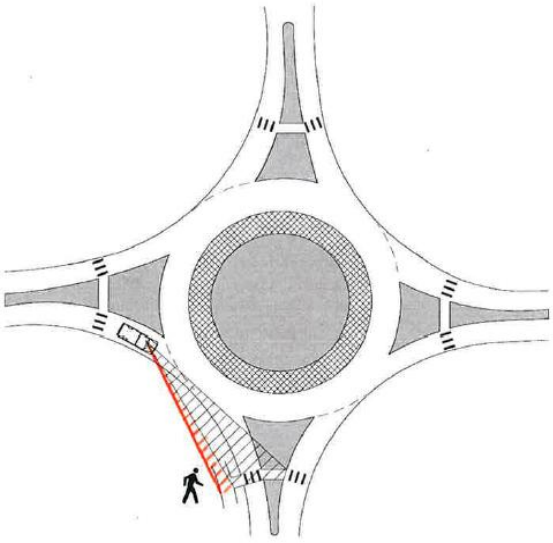
**From:** Tevis, John
**Sent:** Friday, September 11, 2009 7:47 AM
**To:** Focke, Ted
**Cc:** Lippincott, Greg; Sielbach, Kurt
**Subject:** RE: Chapter 1320, Roundabouts policy Review

Ted,

These Sight Distance examples have very different formats and could be worked on to make them the same. And if we decided to do it I would be happy to help. But as a minimum the below change needs to be made.



**Comment [TWF1]:** Revise drawings 21 & 23. Area covered should be similar, car in 23 should be in roundabout.

**JOHN TEVIS**
SWR | NWR Design Liaison Engineer

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**From:** Bellinger, Dave
**Sent:** Thursday, September 17, 2009 7:10 AM
**To:** Focke, Ted
**Subject:** FW: Chpt 1320 Review
**Attachments**: 1320PolicyReviewcmw.doc

SWR Comments

**Comment [TWF2]:** Merged

**From:** Mowlds, Rick
**Sent:** Friday, September 18, 2009 11:37 AM
**To:** Focke, Ted
**Cc:** Walsh, Brian
**Subject:** Design Manual Chapter 1320 - Roundabouts

Hi Ted,

For you consideration, the Traffic Office requests the following text be added to the Roundabout Design Manual chapter:

A roundabout sign plan is developed to identify existing and proposed signing on state highways and is reviewed by the region Traffic Engineer. Roundabout sign plans on the state routes are to be furnished to the HQ Traffic Office for review and concurrence. The plan provides an easily understood graphic representation of the signing and to provide statewide uniformity and consistency for regulatory, warning, and guide signs at roundabouts on the state highway system. The roundabout sign plan is reviewed and approved by the region Traffic Engineer.

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**Comment [TWF3]:** I plan to remove most of the signing information and replace it with references to the MUTCD & Traffic Manual.

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If you have any questions or concerns, please let me know.

Thank you in advance for considering our request.

*Rick Mowlds*

Signing Engineer
WSDOT HQ Traffic Operations - Olympia
(360) 705-7988
Cellular (360) 789-9172
FAX (360) 705-6826
mowldsr@wsdot.wa.gov

**From:** Engel, Dennis
**Sent:** Thursday, October 01, 2009 7:38 AM
**To:** Focke, Ted
**Subject:** RE: Chapter 1320, Roundabouts policy Review

<< File: 1320PolicyReviewFS.doc >>

**Comment [TWF4]:** Merged.

Here are comments from Olympic Region Traffic.

**From:** Olson, Ken (Eastern Region)
**Sent:** Friday, October 02, 2009 10:34 AM
**To:** Focke, Ted
**Subject:** 1320PolicyReviewER.doc
**Attachments**: ER Review comments .xls; 1320PolicyReviewER.doc

Ted,

**Comment [TWF5]:** Merged.

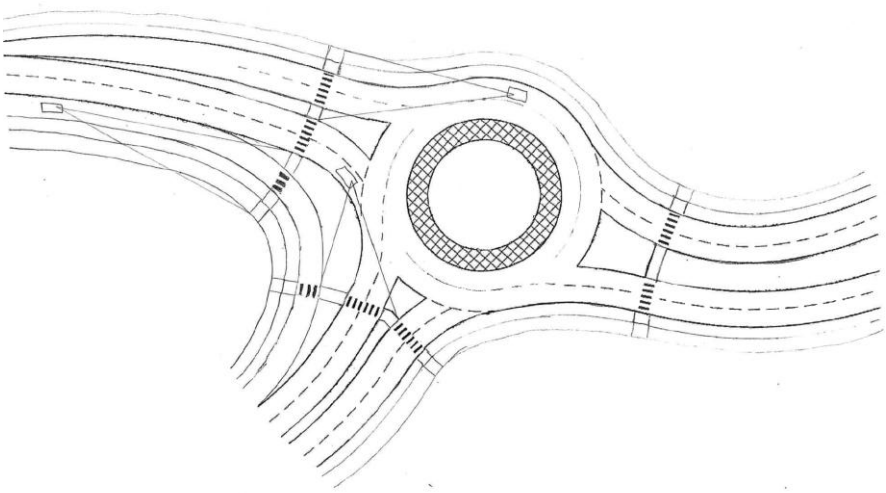
Thanks for your help on this. I'm also including an excel comment sheet for ER comments so you can see original authors and an easier way of seeing the comments ER had. If you have input on how to make your job easier let me know.

Thanks,
Ken

**From:** Tevis, John
**Sent:** Tuesday, October 06, 2009 8:39 AM
**To:** Focke, Ted
**Cc:** Lippincott, Greg; Sielbach, Kurt
**Subject:** RE: REVIEW & SEND - RE: Chapter 1320, Roundabouts policy Review

<< File: SightTriangles_001.pdf >>
Ted, One more thing. Attached is a sight triangle detail that needs to be a figure for Roundabouts with less than 4 legs and roundabouts with right-turn slip lanes.

Thus:



**Comment [TWF6]:** A version of this can replace both 21 & 23

JOHN TEVIS
SWR | NWR Design Liaison Engineer
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**From:** Tevis, John
**Sent:** Monday, October 05, 2009 1:04 PM
**To:** Focke, Ted
**Cc:** Lippincott, Greg
**Subject:** FW: REVIEW & SEND - RE: Chapter 1320, Roundabouts policy Review

Ted, The Word and PDF files below are Kurt and My comments for this chapter.

JOHN TEVIS
SWR | NWR Design Liaison Engineer
HQ Design Office 2B25 (360) 705-7460

**From:** Sielbach, Kurt
**Sent:** Friday, October 02, 2009 2:39 PM
**To:** Tevis, John
**Subject:** REVIEW & SEND - RE: Chapter 1320, Roundabouts policy Review

Hi John,

Attached is the file that we reviewed the other day. If you have any other comments please add to and then forward to Ted.

Thanks,

<< File: 1320PolicyReview Roundabout 102-09 ks jt.doc >> << File: 1320 Review_001.pdf >>

Kurt
7937

**From:** Anderson, Sally
**Sent:** Thursday, October 08, 2009 4:11 PM
**To:** Focke, Ted
**Subject:** RE: Chapter 1320, Roundabouts policy Review

Per discussion, I missed looking at this. For the next revision please strengthen the ped crossing info. I can help. ADA needs to be strengthened, in particular how the islands are to be crossed, detectable warning surface locations, width of island. A diagram would help.

**Comment [TWF7]:** To reduce duplication and possible conflict, Ch 1320 should refer to 1510 and not repeat information.

*Sally A. Anderson, LA*

Roadside and Site Development Manager
360-705-7242
Fax 360-705-6815
anderss@wsdot.wa.gov

**From:** Anderson, Sally
**Sent:** Monday, October 12, 2009 11:00 AM
**To:** Focke, Ted
**Cc:** Tevis, John; Lippincott, Greg
**Subject:** FW: Round about ped crossings

FYI

*Sally A. Anderson, LA*

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Visit our website at:

http://www.wsdot.wa.gov/eesc/design/roadside/

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**From:** Tevis, John
**Sent:** Monday, October 12, 2009 6:57 AM
**To:** Anderson, Sally
**Cc:** Lippincott, Greg
**Subject:** RE: Round about ped crossings

Sally, You're absolutely correct. But what the DM needs to explain is that raised splitter islands must be a minimum of 6 feet back of curb to back of curb where pedestrian crossings are located.

**Comment [TWF8]:** In general, when dealing with roadway geometrics, the width is measured from the face of curb, not the back of curb. Therefore, I will change to say 7 ft to include the curb width of 6" each.

**JOHN TEVIS**
SWR | NWR Design Liaison Engineer
HQ Design Office 2B25 (360) 705-7460

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**From:** Anderson, Sally
**Sent:** Thursday, October 08, 2009 4:06 PM
**To:** Lippincott, Greg; Tevis, John
**Subject:** Round about ped crossings

FYI: I just learned that the DM has existing guidance in 1320.07 that raised splitter islands must be 6 feet where pedestrian crossings are located. They should have done it! I just can't leave it alone. :-)))

*Sally A. Anderson, LA*

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Fax 360-705-6815
anderss@wsdot.wa.gov

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**From:** Drye, Jay
**Sent:** Thursday, October 08, 2009 4:02 PM
**To:** Focke, Ted
**Subject:** FW: Ch 1320

Ted,
Thanks for your assistance today. Attached are the comments for the Mount Baker Area. If you need clarification or have any questions, please don't hesitate to call. This is a very important revision and chapter for us. thanks
<< File: 1320PolicyReview.doc >>

**Comment [TWF9]:** Merged.

Jay Drye
Engineering Manager
WSDOT- Mt Baker Area
(360) 757-5993

**From:** don.petersen@dot.gov [mailto:don.petersen@dot.gov]
**Sent:** Tuesday, October 13, 2009 5:58 PM
**To:** Focke, Ted
**Subject:** Chapter 1320

Ted…

I have attached Chapter 1320. I agree with most of the comments that the other offices had (can live with all the comments). I don't have any additional comments.

<<1320PolicyReview.doc>>

**Comment [TWF10]:** Merged

*Don*

Don Petersen
Safety/Design Engineer
FWHA - Washington Division
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Olympia, Washington 98501
Phone:360-534-9323
Fax: 360-753-9889
Don.Petersen@dot.gov

**From:** Macek, Ian
**Sent:** Thursday, October 15, 2009 4:24 PM
**To:** Olson, Dave
**Subject:** DM Updates

Dave-

I saw that the following chapters were being updated and may have items relevant to walking/bicycling. I'm sending the comments below to you since the comment period had passed. Fairly minor additions, but worth looking into.

Traffic Signals **http://www.wsdot.wa.gov/Design/Manual/ActiveRevisions.htm#1330**

- Include the new motorcycle and bicycle detection law (SB 5482) at the beginning of the chapter. The chapter should also mention that bicycle lanes will need to detect cyclists at signals.
- I believe the new edition of the MUTCD is looking at the placement of Accessible Pedestrian Signal push buttons, with a min width between buttons, should this be reflected in the updated chapter (or may already be addressed elsewhere)?

Roundabouts **http://www.wsdot.wa.gov/Design/Manual/ActiveRevisions.htm#1320**

- The image showing bike lanes coming into a roundabout needs clarification (p 1320-45). As is, the drawing indicates that bike lanes should be striped right to the ramp, indicating that cyclists should use the sidewalk. As cyclists have a choice, a dashed bike lane stripe may be more appropriate coming into the roundabout so a bicyclist can decide whether to move into the general travel lane or go onto the sidewalk.

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- From ODOT: The bike lane should be dropped about 30-50 feet prior to the entry lane crosswalk, and dashed for approximately 30 feet. A ramp should be provided where the dashes begin to allow cyclists to use the sidewalks and crosswalks to negotiate the roundabout, if they prefer.

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If you have any questions, or need clarification/assistance, please let me know.

Thanks,

Ian Macek

State Bicycle & Pedestrian Coordinator
Washington State Department of Transportation
310 Maple Park Ave SE
PO Box 47390
Olympia, WA 98504
360.705.7596

**From:** Lagergren, Ed
**Sent:** Monday, October 19, 2009 12:59 PM
**To:** Berens, Bill
**Cc:** Walsh, Brian; Focke, Ted
**Subject:** FW: Roundabout Pavement striping details

Bill,

As you can see below, Brian has asked me to put together a standard plan on roundabouts. I picture it as similar to Standard Plan M-15.10, Crosswalk Layout.

There are a number of roundabout changes scheduled for the next issue of the MUTCD. We have the latest proposals, however, they are not officially adopted by either the FHWA or WSDOT. This should be a consideration. Standard Detail?

Most of the striping is done with existing markings. We will need a new entrance line detail.

Anyway, let me know when you want to get started.

**Comment [TWF11]:** As a Standard Plan, this is OK. For the *Design Manual*, the only change should be to the multilane example exhibits. Other striping exhibits should be removed and replaced with references to the MUTCD, *Traffic Manual*, and *Standard Plans*.

Thanks.

Ed Lagergren, P.E.
Traffic Design Standards and Materials Manager
WSDOT Traffic Operations Office
310 Maple Park Avenue SE
P.O. Box 47344
Olympia, WA 98504-7344
360-705-7284

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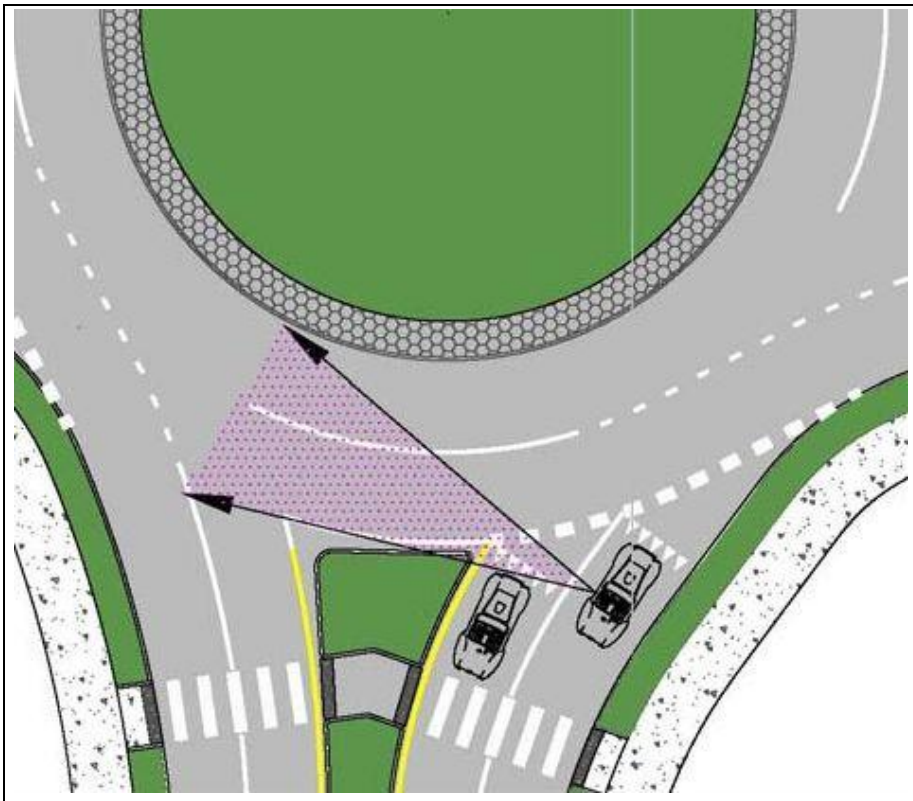
**From:** Walsh, Brian
**Sent:** Friday, October 16, 2009 11:03 AM
**To:** Lagergren, Ed
**Subject:** Roundabout Pavement striping details



Ed,
Can i ask you to put this item on your list or delegate it. We need to have a standard plan detail that shows the difference between a 12" wide skip (and closely spaced" entry line and the 6" dashed and solid lines used for the circulating roadway. It has been pointed out to me as well as my own observation that our striping at roundabouts, particularly when they are done in paint don't provide positive guidance as you approach a roundabout.....a critical component in lane use by motorists as they make decision prior to entering the roundabout. I am going to request of Ted Focke that the striping detail in DM Chapter 1320 be updated to show the thickness of the lines. That will probably happen in the 2010 revision.

Thanks,
Brian W.

# Chapter 1320 Roundabouts



## 1320.01 General

Modern roundabouts are circular intersections at grade. They are an effective intersection type with fewer conflict points and lower speeds, and they provide for easier decision making than conventional intersections. They also require less maintenance than traffic signals. Well-designed roundabouts have been found to reduce crashes (especially fatal and severe injury collisions), traffic delays, fuel consumption, and air pollution. They also have a traffic-calming effect. ~~For additional information and details on roundabouts, see *Roundabouts: An Informational Guide*.~~.

Selection of a roundabout is based on an engineering analysis that examines traffic volumes, traffic patterns, space needs, and right of way availability. See Design Manual Chapter 1310 for more information on selecting the intersection control.

Modern roundabouts differ from older circular intersections in three ways: they have splitter islands that provide entry deflection to slow down entering vehicles; they have yield-at-entry, which requires entering vehicles to yield to vehicles in the roundabout to allow free flow of circulating traffic; and they have a smaller diameter that constrains circulating speeds.

The characteristics of a roundabout are dependant on the surrounding area, the type of facility, post speed limits on the roadway, development, and the types of users that are found. In general the characteristics can be considered either urban or rural.

Urban characteristics include:

- Lower posted speeds (less than 40 mph)
- Commercial and residential areas along the roadway
- Shorter splitter islands
- Prevalent pedestrian activity

Rural characteristics include:

- High speed roadways (40 mph and above)
- Commercial and rural areas along the roadway

**Comment [TWF12]:** *[From OR in text]* Note: This statement about RABs may be an assumption that includes no pedestrian signal crossing for sight impaired ADA, low posted speeds, a significant history of injury collisons, and under capacity conditions (Our internal analysis indicates RABs may increase veh-sec of delay when replacing two-way minor street stop and single stop controlled intersections, particularly in rural high-speed mainline locations with low minor street volumes in an overcapacity future condition) *[This statement is based on existing information for "well-designed" roundabouts.]*

**Comment [ORTraffic13]:** Refer reader to section *(1320.02(3))*. *[Deleted]*

**Comment [KS14]:** This needs to be updated to discuss the situations we are encountering: Urban & Rural. Suggest below: *[This is not intended to describe modern roundabouts, but to give the difference between them and old traffic circles.]*

- Longer and more curvilinear splitter islands are needed to reduce approach speeds
- Pedestrian considerations are on a case-by-case analysis

**Comment [TWF15]:** I believe that this would be better in 1320.04, Roundabout Types.

## 1320.02 References

### (1) Federal/State Laws and Codes

Americans with Disabilities Act of 1990 (ADA)

Revised Code of Washington (RCW) 47.05.021, Functional classification of highways

Washington Administrative Code (WAC) 468-58-080, Guides for control of access on crossroads and interchange ramps

### (2) Design Guidance

*ADA Accessibility Guidelines for Buildings and Facilities* (ADAAG), U.S. Access Board
www.access-board.gov/adaag/html/adaag.htm

*ADA Standards for Accessible Design*, U.S. Department of Justice
www.usdoj.gov/crt/ada/adahom1.htm

*Local Agency Guidelines* (LAG), M 36-63, WSDOT

*Manual on Uniform Traffic Control Devices for Streets and Highways*, USDOT, FHWA, as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)

*Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans)*, M 21-01, WSDOT

*Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications)*, M 41-10, WSDOT

### (3) Supporting Information

*A Policy on Geometric Design of Highways and Streets* (Green Book), AASHTO, 2004

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~~"Crash Reductions Following Installation of Roundabouts in the United States," Insurance Institute for Highway Safety, March 2000~~
~~www.nysdot.gov/portal/page/portal/main/roundabouts/files/insurance_report.pdf~~

**Comment [TWF16]:** Move to keep alphabetic order.

**Comment [TWF17]:** Keep original alphabetic order.

**Comment [KS18]:** There is more current information available at the IIHS website – just reference the site??
[*Delete, I believe references should only be to documents*

*Guide to Traffic Engineering Practice, Part 6 – Roundabouts* (Austroad Guide), Sydney, Australia: Austroad, 1993

*Highway Capacity Manual* (HCM), Special Report 209, Transportation Research Board, National Research Council

*Modern Roundabout Practice in the United States*, NCHRP Synthesis 264, Transportation Research Board, 1998
onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_264.pdf

*Roundabouts in the United States*, NCHRP Synthesis 572, Transportation Research Board, 2007
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_572.pdf

*Roundabouts: An Informational Guide*, FHWA-RD-00-067, USDOT, FHWA
www.tfhrc.gov/safety/00068.htm

~~*Roundabouts: An Informational Guide*, FHWA-RD-00-067, USDOT, FHWA~~
~~www.tfhrc.gov/safety/00068.htm~~

~~*Roundabout Design Guidelines*, Ourston & Doctors, Santa Barbara, California, 1995~~

~~*The Traffic Capacity of Roundabouts*, TRRL Laboratory Report 942, Kimber, R.M., Crowthorne, England: Transport and Road Research Laboratory, 1980~~

~~"Use of Roundabouts," ITE Technical Council Committee 5B-17, Feb. 1992~~
~~www.ite.org/traffic/documents/JBA92A42.pdf~~

*The Design of Roundabouts: State of the Art Review*, Brown, Mike, Transportation Research Laboratory, Department of Transport. London, HMSO, 1995

*Understanding Flexibility in Transportation Design – Washington*, WSDOT, 2005
www.wsdot.wa.gov/eesc/design/Urban/

**Comment [TWF19]:** Move to keep alphabetic order.

**Comment [TWF20]:** Keep original alphabetic order.

**Comment [KS21]:** This is out of print *[Delete]*

**Comment [KS22]:** Not very easy to obtain *[Delete]*

**Comment [KS23]:** Suggest deleting as it is very outdated *[OK]*

## 1320.03 Definitions

Note: For definitions of ***design speed***, ***functional classification***, ***highway***, and ***roadway***, see Chapter 1140; for ***lane*** and ***lane width***, see Chapter 1230; for ***superelevation***, see Chapter 1250; for ***sight distance*** and ***stopping sight distance***, see Chapter 1260; for ***design vehicle***, ***intersection at grade***, ***intersection sight distance***, and ***island*** see Chapter 1310; and for ***detectable warning surface***, see Chapter 1510.

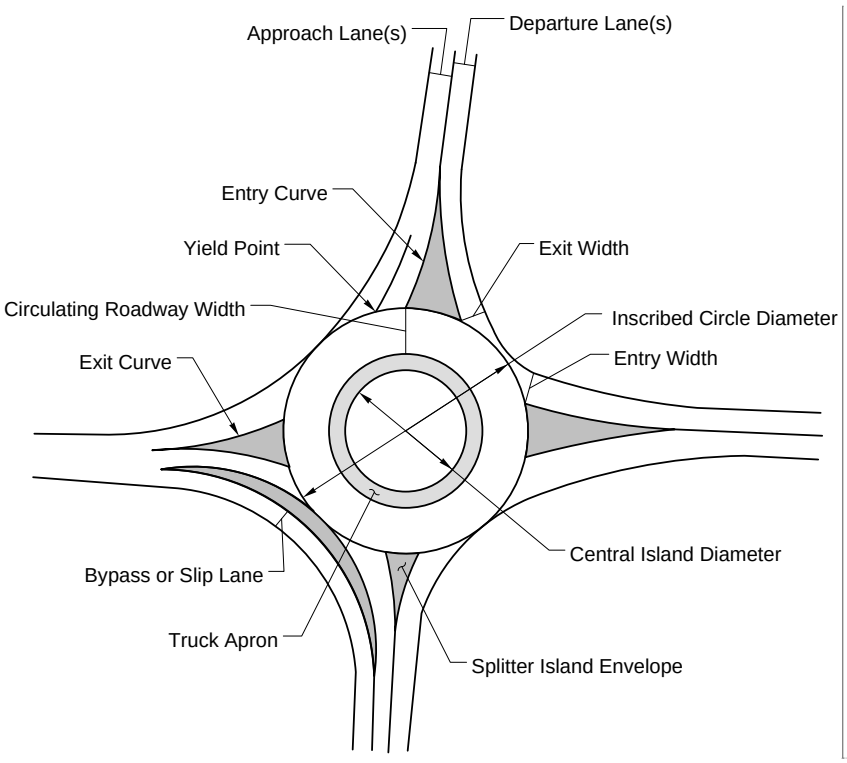
***approach design speed*** The design speed of the roadway leading ~~into~~ up to the roundabout.

***approach lanes*** The lane or set of lanes for traffic approaching the roundabout (see Exhibit 1320-1).

***central island*** The area of the roundabout, including the truck apron, surrounded by the circulating roadway.

***central island diameter*** The diameter of the central island, including the truck apron (see Exhibit 1320-1).

***circulating lane*** A lane used by vehicles circulating in the roundabout.




**Comment [KS24]:** Need to update this exhibit Show the splitter islands, ped crossings, revise departure to exit
*[The only purpose for this drawing is to identify elements that are defined.]*

**Roundabout Elements**
***Exhibit 1320-1***

***circulating roadway*** The traveled lane(s) adjacent to the central island and outside the truck apron, including the entire 360° circumference of the circle.

***circulating roadway width*** The total width of the circulating lane(s) measured from inscribed circle to the central island (see Exhibit 1320-1).

***conflict point*** A point where traffic streams cross, merge, or diverge.

***deflection*** The change in the path of a vehicle imposed by the geometric features of a roundabout resulting in a slowing of vehicles (see Exhibit 1320-15a).

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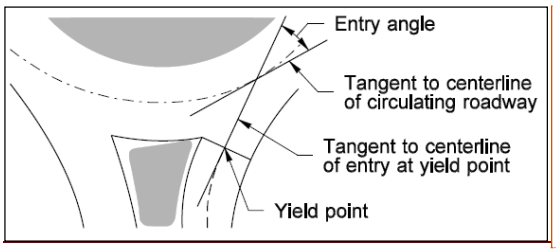



**Comment [JT25]:** No use. Recommend deleting….
*[OK]*

~~**Entry Angle**~~
~~***Exhibit 1320-2***~~

~~***entry angle*** The angle between the entry roadway and the circulating roadway measured at the yield point (see Exhibit 1320-2).~~

***entry curve*** The curve of the left edge of the roadway that leads into the circulating roadway (see Exhibit 1320-1).

***entry width*** The width of an entrance leg at the inscribed circle measured perpendicular to travel (see Exhibit 1320-1).

***exit curve*** The curve of the left edge of the roadway that leads out of the circulating roadway (see Exhibit 1320-1).

~~***departure*** ***E***~~***e***~~*xit* ***lane***~~*(****s****)*~~ The lane or set of lanes for traffic leaving the roadway (see Exhibit 1320-1).

***exit width*** The width of an exit leg at the inscribed circle (see Exhibit 1320-1).

***flare*** The widening of the approach to the roundabout to increase capacity and facilitate natural vehicle paths.

***inscribed circle*** The outer edge of the circulating roadway.

***inscribed circle diameter (ICD)*** The diameter of the inscribed circle (see Exhibit 1320-1).

~~***double*** ***M***~~***m****ulti* ***-lane roundabout*** A roundabout with at least a two-lane circulating roadway and one or more entry or exit legs with two or more lanes.

***natural vehicle path*** The natural path that a driver navigates a vehicle given the layout of the intersection and the ultimate destination.

***roundabout*** A circular intersection at grade with yield control of all entering traffic, channelized approaches with raised splitter islands, ~~and~~ counter-clockwise circulation, and appropriate geometric curvature to force travel speeds on the circulating roadway generally to less than 25 mph.

***single-lane roundabout*** A roundabout having single-lane entries at all legs and one circulating lane.

***slip lane*** A lane that separates heavy right-turn movements from the roundabout circulating traffic (see Exhibit 1320-1).

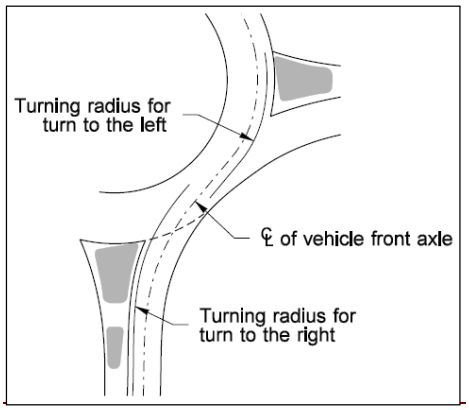
***splitter island*** The raised island at each two-way leg between entering and exiting vehicles, designed primarily to control the entry and exit speeds by providing deflection. They also discourage wrong-way movements, and provide pedestrian refuge.

***truck apron*** The optional mountable portion of the central island of a roundabout between the raised nontraversable area of the central island and the circulating roadway (see Exhibit 1320-1).

**Comment [KS26]:** Does this need to remain? Recommend deleting *[OK]*

**Comment [KS27]:** Where did this definition come from? *[This is the definition that came from the interdisciplinary team that developed the original chapter, except the speed was 25mph. It, primarily came from the FHWA guide.]*

**Comment [KS28]:** This is not just for circulating roadway and want to reduce speeds to less than 25 mph. Recommend deleting. *[Keep, this is as given in the FHWA guide.]*




~~**Turning Radius (R)**~~
~~***Exhibit 1320-3***~~

Comment [KS29]: Is this needed? Delete
*[OK, but other changes will be needed.]*

~~***turning radius*** — The radius that the front wheel of the design vehicle on the outside of the curve travels while making a turn (see Exhibit 1320-3).~~

Comment [KS30]: Delete
*[Same]*

***yield-at-entry*** The requirement that vehicles on all entry lanes yield to vehicles within the circulating roadway.

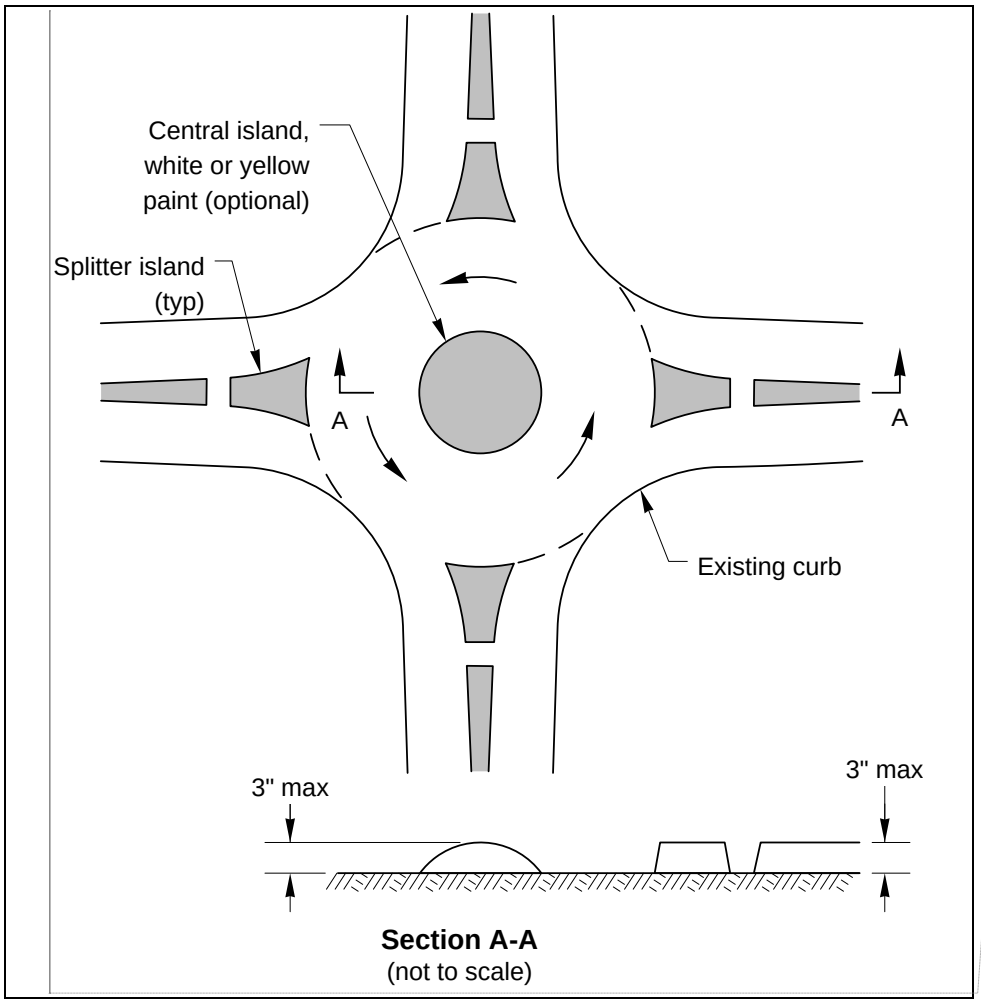
***yield point*** The point at which entering traffic must yield to circulating traffic before entering the circulating roadway (see Exhibit 1320-1).

## 1320.04 Roundabout Types

There are four basic roundabout types: mini, single-lane, multilane, and teardrop.

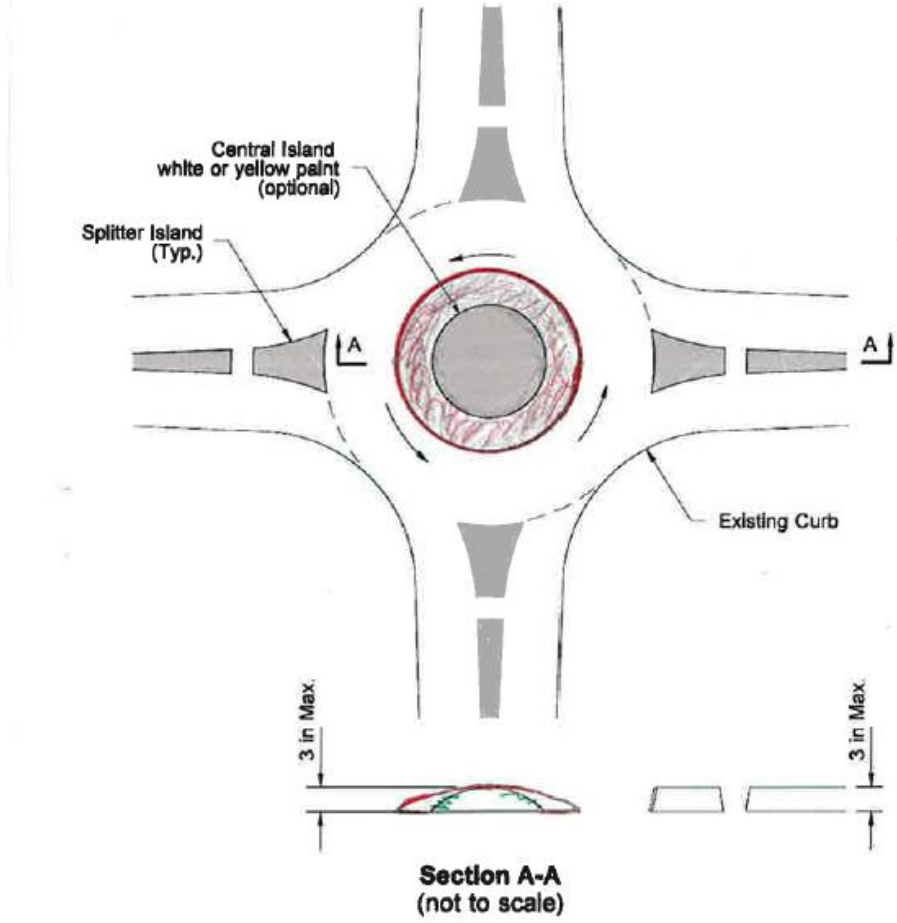
### *(1) Mini Roundabouts*

Mini roundabouts are small single-lane roundabouts that are used in low-speed (25 mph or less) urban environments where the design vehicle is the P vehicle (see Chapter 1310). Because of this, mini roundabouts are typically not suitable for use on state routes. In retrofit applications, mini roundabouts are relatively inexpensive because they normally require minimal additional pavement at the intersecting roads. A 3-inch mountable curb for the splitter islands and the central island is desirable because larger vehicles might be required to cross over it. A common application is to replace an all-way stop-controlled intersection with a mini roundabout to reduce delay and increase capacity. With mini roundabouts, the existing curb and sidewalk at the intersection can be left in place (see Exhibit 1320-4).




**Section A-A**
(not to scale)

**Comment [KS31]:** Section A-A needs work: Crosswalks, sidewalks, etc Also see John Tevis's drawing *[For a "not-to-scale" cartoon, I don't believe that the changes are needed.]*



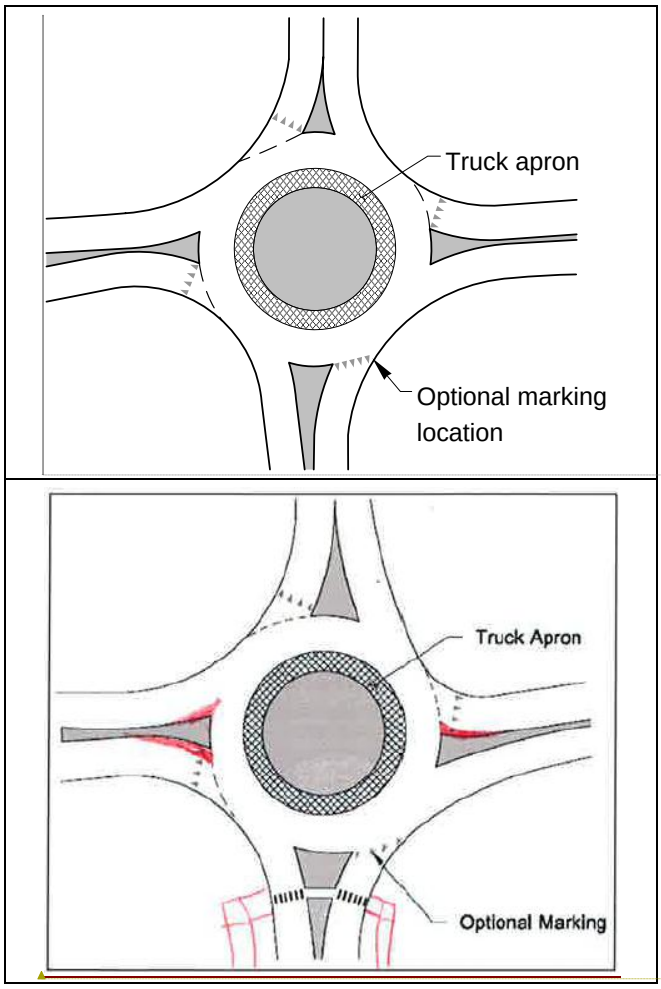

**Notes:**

- The central island and splitter island are mountable islands.
- A mini roundabout has similar details as a single-lane roundabout, except all islands are mountable and existing curb and sidewalk at the intersection can remain.

**Mini Roundabout**
***Exhibit 1320-4***

## *(2) Single-Lane Roundabouts*

Single-lane roundabouts have single-lane entries at all legs and one circulating lane. They typically have nonmountable raised splitter islands, a mountable truck apron, and a nonmountable central island (see Exhibit 1320-5).




**Comment [KS32]:** Left & Right leg entry is not drawn correctly
*[Exhibit redrawn, crosswalk removed]*

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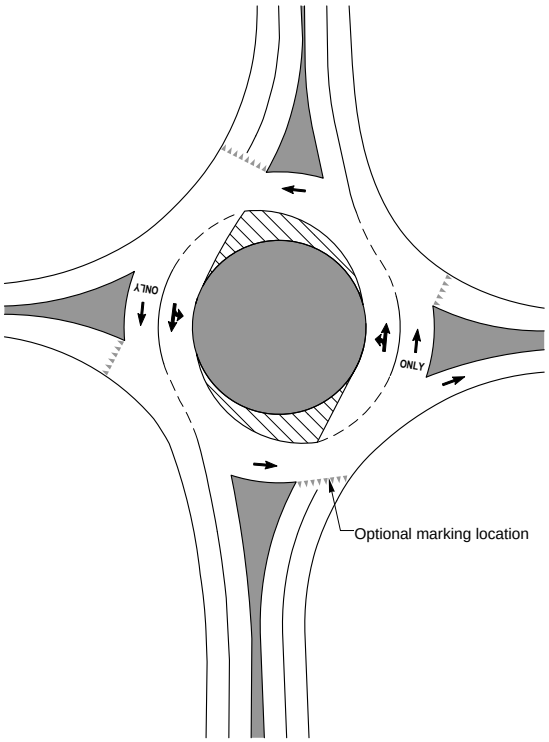
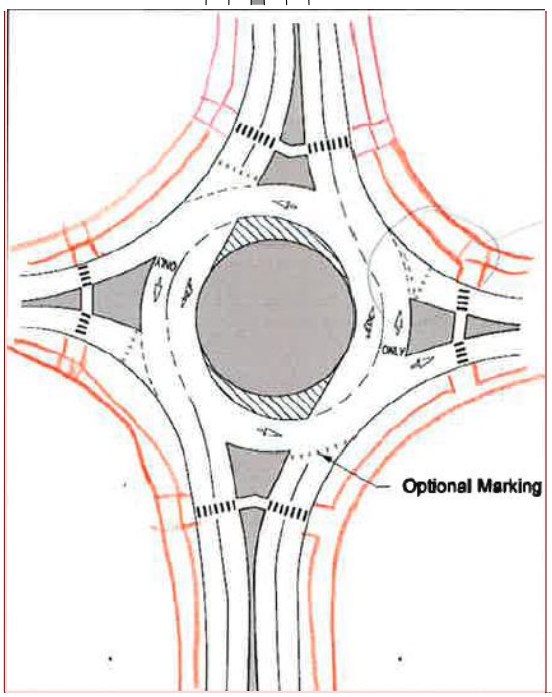
**Single-Lane Roundabout**
***Exhibit 1320-5***

### *(3) Multilane Roundabouts*

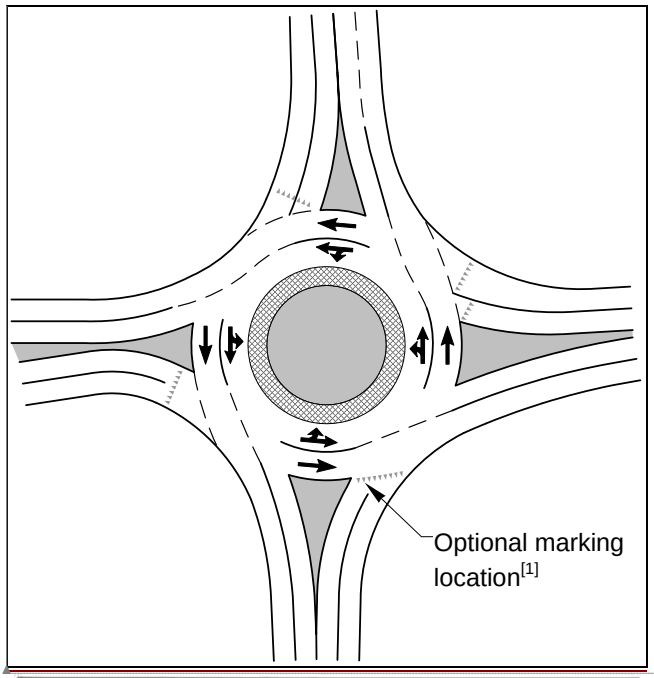
Multilane roundabouts have at least one entry or exit with two or more lanes and more than one circulating lane (see Exhibits 1320-6a, 6b, and 6c). To balance the needs of passenger cars and trucks and control speeds, the current operational practice is normally for trucks negotiating roundabouts to encroach on adjacent lanes (see Exhibit 1320-14b).

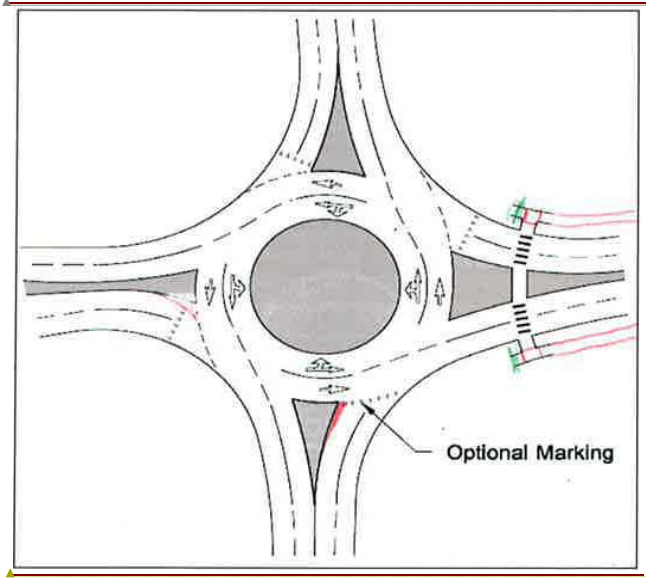



**Comment [TWF33]:** Remove all crosswalks and pedestrian facilities.

**Multilane Roundabout**
***Exhibit 1320-6a***




**Multilane Roundabout**
***Exhibit 1320-6b***

**Comment [KS34]:** See John Tevis's drawing. Also make a note that pedestrian and bike ramps and connections

**Field Code Changed**

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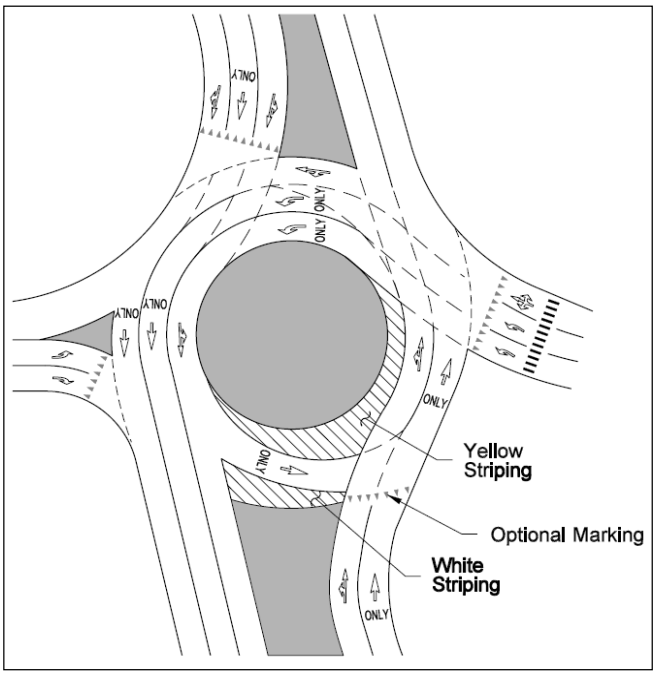
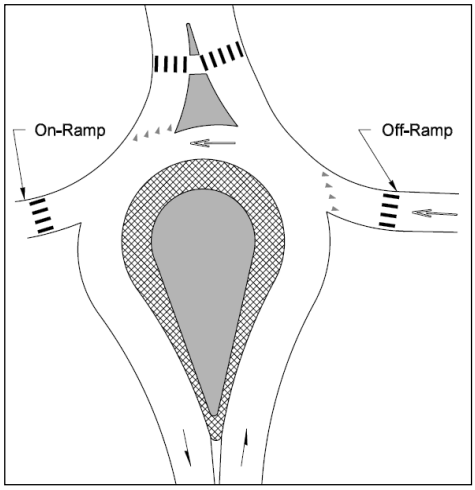


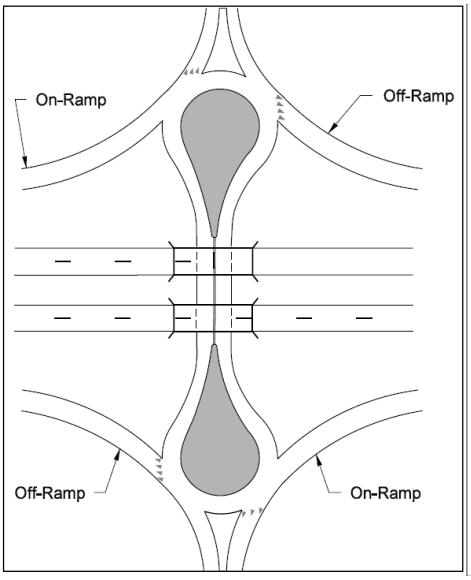

**Multilane Roundabout**
***Exhibit 1320-6c***

### *(4) Teardrop Roundabouts*

Teardrops are usually associated with ramp terminals at interchanges; typically, at diamond interchanges. Teardrop roundabouts allow the "wide node, narrow link" concept. Unlike circular roundabouts, teardrops do not allow for continuous 360° travel. This design offers some advantages at interchanges. Traffic traveling on the crossroad (link) between ramp terminal intersections (nodes) does not encounter a yield as it enters the teardrop intersections. Because this improves traffic throughput on the crossroad between the ramps, it reduces the need for additional lane capacity, thus keeping the cross section between the ramp terminals as narrow as possible (see Exhibits 1320-7a through 7c).




**Teardrop Roundabout at a Ramp Terminals**
***Exhibit 1320-7a***

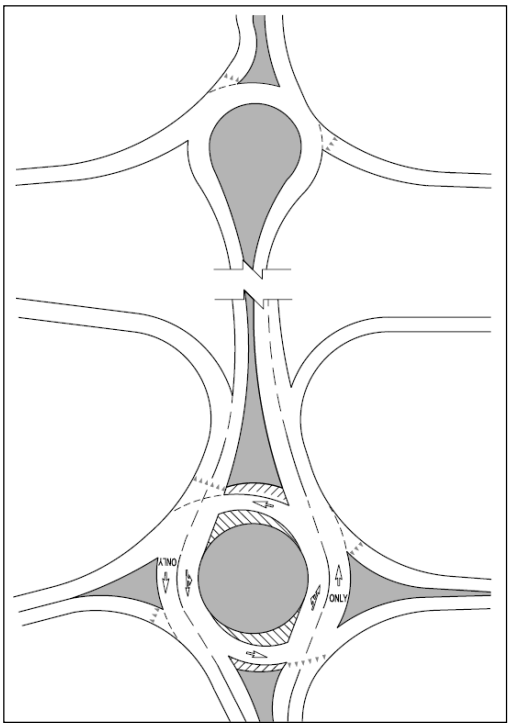



**Comment [KS35]:** Missing the lane stripe in the upper roadway

**Dog Bone Roundabouts ~~Double Teardrop~~**

***Exhibit 1320-7b***

**Comment [KS36]:** Not sure where this term came from??



**Comment [KS37]:** This drawing needs to be worked on. Should the freeway be shown?

**Teardrop Roundabout and a Multilane Roundabout with Spiral Striping~~With Ramps~~**

***Exhibit 1320-7c***

## 1320.05 Capacity Analysis

Complete a capacity analysis before choosing an intersection type and configuration. Use the capacity analysis to design the number of lanes for the traffic in the design year. ~~Use SIDRA Solutions software or the guidance given in the *Highway Capacity Manual*.~~ Contact the region or Headquarters (HQ) Traffic Office for currently approved capacity analysis software and capacity analysis assistance.

## 1320.06 Geometric Design

### *(1) Typical Design Process*

Roundabout design is an iterative process in which small changes in geometry can result in substantial changes to operational performance. It is advisable to prepare the initial layout drawings at a sketch level of detail using either ~~,~~ an existing scaled plan sheet, base map, or aerial photograph. The intent is for the designer to quickly develop the roundabout footprint for the intersection without expending a lot of time or resources drafting PS&E-quality plans. Refer to Section 1320.12 for more guidance on the completion of a conceptual design process. Although it is easy to get caught up in the desire to design each of the individual components of the geometry, it is much more important that the individual components are compatible with the capacity analysis so the roundabout meets its overall performance objectives.

Roundabout design is a performance-based process. Design components are interrelated and changing one affects others, so it is important to evaluate the performance of the entire design as changes are made. There are often several acceptable roundabout designs for a given location that meet design performance objectives; however, this is rarely achieved on the first iteration. The location and size of the roundabout, ~~angle of~~entry curves ~~the approaches~~, and other design components will change as the adequacy of the roundabout design is assessed. Exhibits 1320-13a and 13b illustrate the steps to take on a scaled drawing when designing a roundabout.

**Comment [KS38]:** Suggest revising to- never

After conceptual work has been completed Tools are available to the designer to transfer iteration designs into CADD, which can be useful in verifying the iteration design will work. Use of CADD for placing the design roundabout inscribed circle diameter and the central island, and establishing the circulating roadway, is a quick way to verify that the design vehicle can “drive” the roundabout.

**Comment [KS39]:** What tools are being referenced?

| Design Element | Mini[1] | Single-Lane | Multilane |
|---|---|---|---|
| Number of Lanes | 1 | 1 | 2+ |
| Inscribed Circle Diameter[2] | 45'–80' | 80'–150'[3] | 150' min |
| Circulating Roadway Width | N/A | 14'–19' | 29' min |
| Entry Widths | N/A | 12'–18' | 25' min |

**Notes:**

[1] For use on low-speed residential urban streets only. Mini roundabouts require a deviation on a state route.

[2] The given diameters assume a circular roundabout.

[3] Central Island Diameters of less than 100 feet are not appropriate on a state route.

**Initial Ranges**
***Exhibit 1320–8***

**Comment [PR40]:** (max 170' per WB67 radii Exhibit 1310-11)

**Comment [KS41]:** Does Brian Walsh have any updates on dimensions shown?

## *(2) Design Performance Objectives*

General characteristics of different roundabout types are summarized in Exhibit 1320-8~~....~~ These are not design limits but general guidelines to follow to begin the design process; final design values will vary.

**Comment [KS42]:** Move this exhibit to below this paragraph

### (a) Design Vehicle Turning Paths

One of the elements that control the geometric design of a roundabout is the physical characteristics of the design vehicle. [~~Provide for the WB-67 for all state route-to-state route movements.~~] Provide for the WB-67 for all state route-to-state route movements and significant freight related intersections. Complete auto turn paths to verify that the design vehicle, WB-67, and largest oversize vehicle can enter, circulate and exit the roundabout smoothly and without any hindrance. Use freight routes to help identify the oversized loads that could be expected.~~Provide for the WB-67 for all state route-to-state route movements.~~ ~~(See Chapter 1310 f~~For ~~additional~~ guidance on the selection of a design vehicle, see Chapter 1310.~~)~~ As with other intersections, it is possible that the design vehicle may differ for each movement.

**Comment [ORTraffic43]:** WB-67 for SR to SR is above what is shown in chapter 1310. Is this the new direction and will chapter 1310 change in later updates? Seems like it could increase the speeds of passenger cars in the roundabout and seems a little overkill on design

Design a roundabout such that the design vehicle can use it with a ~~1~~2-foot clearance from the turning radius to any nonmountable curb face. If the curb ~~face~~ is mountable, ~~no~~ zero clearance is needed [~~no clearance is needed~~1-foot clearance should be provided] between the truck turning radius and the edge of the lane. Also, design such that the front wheels of the design vehicle do not encroach on the truck apron. The vehicle path through a roundabout contains multiple curves~~....~~ Use computer-generated vehicle turning path templates (like Autoturn) to verify that each movement can be made by its identified design vehicle(s), including U-turns. Check the entire path of every route through the roundabout (see Exhibits 1320-14a and 14b).

**Comment [KS44]:** Was the intent of the WB 67 reference to ensure that this truck could make it thru the roundabout? See added sentence to address this. As noted in the last sentence there might be a leg of the roundabout that might not need to be sized for a WB -67.

**Comment [W45]:** A larger shy distance is needed to account for driver error and differences in vehicles.

**Comment [KS46]:** Delete?

For multilane roundabouts (two or more circulating lanes), to balance the needs of passenger cars and trucks and control speeds, a design vehicle path may encroach into adjacent entry, circulating, and exit lanes. While the objective is to minimize overlap into the adjacent lanes whenever possible, the current operational practice is normally for trucks negotiating roundabouts to encroach onto adjacent lanes (see Exhibit 1320-14b). A truck apron is not normally required on a multilane roundabout; however, it is acceptable if site-specific considerations show it is beneficial.

**Comment [KS47]:** This is out of place, suggest moving to 1320.06(3)(e)

**(b) ~~Fastest Vehicle Path~~Roundabout Speeds - Determination and Verification Requirements~~s~~**

For a roundabout to operate safely and efficiently the approach and circulating speeds of the vehicle must be reduced.~~For a roundabout to operate safely and efficiently, design it to reduce entry speeds~~. A successfully designed roundabout will force the driver to reduce the vehicle speed entering the roundabout and eliminate the need to brake while traversing through and out of the roundabout. The most significant feature that controls the speed at a roundabout is the entry curve deflection.

Vehicle's Fastest Path

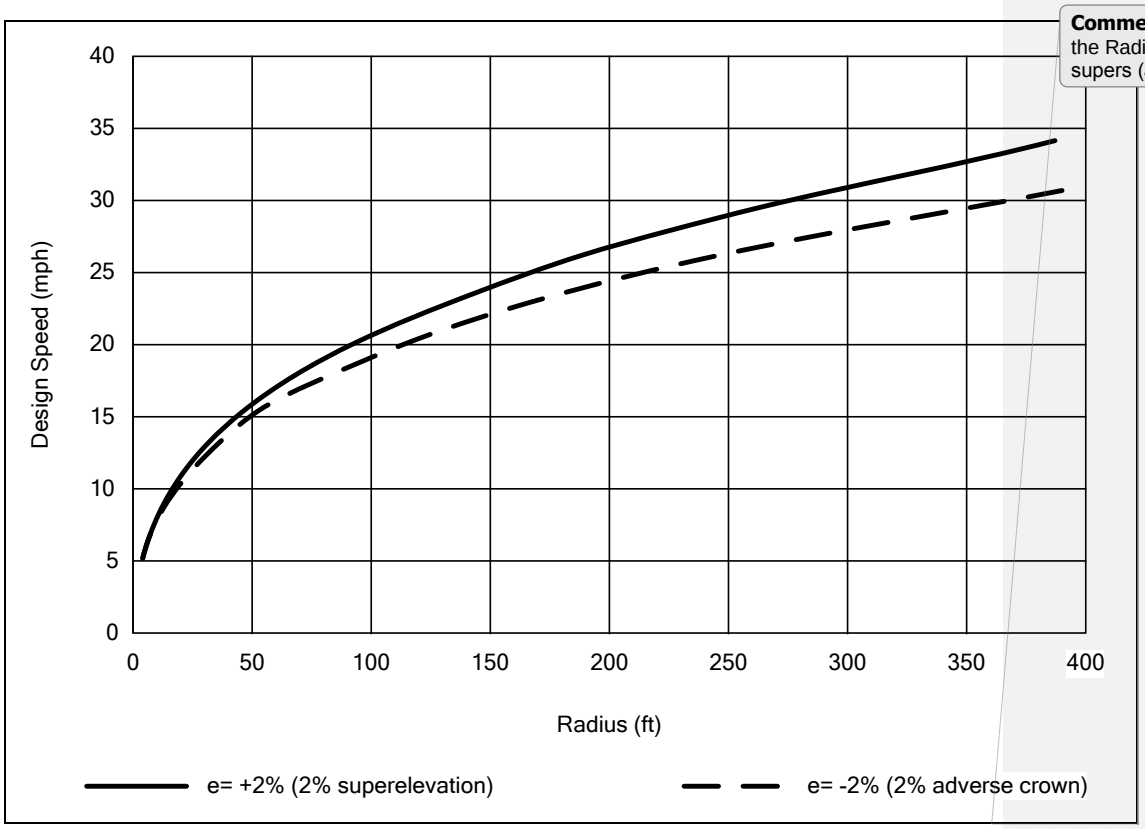
For each direction of travel sketch the fastest path a vehicle can drive though the roundabout.~~The deflection is evaluated by sketching the radius of the centerline of a vehicle traveling along the fastest path through the roundabout.~~ The vehicle's fastest path~~s is are~~ typically drawn by hand for a more natural representation of the way a driver negotiates the roundabout (with smooth transitions connecting a series of reverse curves). Exhibits 1320-15a, 15b, and 15c illustrate the vehicle's fastest paths and depict all radii.

**Comment [KS48]:** Can these exhibits be move to this area?? Also, can we show some sketched fastest paths??

**Comment [KS49]:** Can this be moved to this page?

**Determining the Speed for the Fastest Path Drawn** –Measure the radius (R1 thru R5) as shown in Exhibit 1320-15a for each leg of the roundabout. Using Exhibit 1320-9, which shows the relationship between vehicle path radius and its fastest achievable speed, ~~,~~determine the corresponding speed for each of the radii (R1 – R5). The speed achievable for larger exit radii ($R_3$) is usually not as fast as the speed shown in Exhibit 1320-9. In this case, the exit speed is controlled by the circulating radius ($R_2$) plus acceleration to the exit crosswalk.

**Comment [KS50]:** This is out of place, suggest moving to the bottom of the last paragraph.




**Speed vs. Radius**
***Exhibit 1320-9***

**Check of Speeds and Speed Differentials** - Check all of the fastest path speeds of each curve ~~using Exhibit 1320-9 for curves ($R_1$ through $R_5$) from each approach~~ and modify the design to provide a maximum speed of 25 mph; otherwise, provide justification as to why this can not be obtained or needed. Single-lane roundabouts can usually achieve lower entry speeds than multilane roundabouts.

To maximize efficiency, it is important to minimize the relative speed differential ~~between the consecutive geometric elements of each traffic stream and between conflict~~t at each of the conflict ~~ing traffic streams at each geometric element~~points (see Exhibit 1320-17). Therefore, speed consistency for the through movement ($R_1$ to $R_2$ to $R_3$) and left-turn movement ($R_1$ to $R_4$ to $R_3$) on each approach is an important performance objective (see Exhibit 1320-16~~).).).).).~~. Check speeds of each consecutive set of radii and modify the design such that the difference does not exceed 6 mph; otherwise, provide justification as to why this can not be obtained or needed. Also, for each conflict point, check the speed variation associated with all radii passing through the same point in the roundabout ($R_1$, $R_3$, $R_4$, and $R_5$), and modify the design such that it does not exceed 6 mph; otherwise, provide justification as to why this can not be obtained or needed. ~~Check the speeds at each conflict point (see Exhibit 1320-17)~~.

**Comment [KS51]:** Show the Radius # for the two supers (John T's)

**Comment [KS52]:** Is this needed?

**Comment [KS53]:** Safety???

**Comment [KS54]:** Move exhibits to here

Typically, the radius of the exit curve is larger than the entry curve to improve the ease of exit and does not translate into a faster speed. For the exiting speed (R3) use the lower value of the two speeds: 1) Speed using the measured radius (Exhibit 1320-9); or 2) Speed using the standard acceleration and distance to the crosswalk or merging point.(R2 plus the acceleration rate of 6.9 ft/sec$^2$ times the distance to the crosswalk). The acceleration of 6.9 ft/sec$^2$ is identified in FHWA's NCHRP Report 572. .

**(c) Natural Vehicle Path~~s~~**

The speed and orientation of the vehicle at the yield point determines its natural path through the roundabout. At the yield point, a vehicle enters the circulatory roadway along its natural path and either exits to the right or continues around the central island to another exit. The key principle in drawing the natural path is to remember that drivers cannot change the direction or speed of their vehicles instantaneously. This means that the natural path provides a smooth alignment and does not have sudden changes in curvature; it has transitions between consecutive reversing curves. It also means that consecutive curves have similar radii and are long enough so that vehicles follow the radii of the curves.

To identify the natural path of a given design, sketch the natural paths over the geometric layout rather than using a computer drafting program. In sketching the path by hand, transitions between consecutive curves are similar to the way an operator drives a vehicle. Freehand sketching forces the designer to feel how changes in one curve affect the radius and orientation in the next. This sketching technique allows the designer to quickly obtain a smooth natural path and assess the adequacy of the geometry. Entry design that avoids overlapping paths or curb strikes is shown in Exhibit 1320-18.

If the natural path of a vehicle points the vehicle into a raised curb or interferes with the natural path of an adjacent vehicle, sideswipe crashes and curb strikes may occur (see Exhibit 1320-18). When these types of problems are identified, the geometric design of the roundabout needs to re-analyzed and possibly modified.

## *(3) Design Components*

**(a) Inscribed Circle Diameter (ICD)**

For typical ICD ranges based on the type of roundabout, see Exhibit 1320-8. The capacity analysis determines the number of circulating lanes needed. When sizing the roundabout where there are more than four legs or when two approaches are skewed or close together, start on the higher end of the range for larger design vehicles, ~~when there are more than four legs or when two approaches are skewed or close together~~. It is important to provide an inscribed diameter that accommodates the design vehicle for all movements. A different diameter may be needed if the selected diameter does not accommodate the design vehicle, the fastest paths are not within 6 mph of each other, or a vehicle path is over 25 mph.

The inscribed circle does not always have to be circular with a constant radius circulating roadway. Circular roundabouts are desirable, but ovals can be used when a circle is not possible due to site constraints. Oval roundabouts ~~usually~~

may present more trouble with fastest paths that are too fast. Therefore, a good balance between the geometric design and speed differentials needs to be considered when designing a oval shaped roundabout.

The inscribed diameter consists of the circulating roadway width, a possible truck apron, and a central island. Typical ranges for the circulating roadway width are shown in Exhibit 1320-8.

- For single-lane roundabouts, start by trying an 18-foot-wide circulating roadway and size the truck apron width to accommodate the design vehicle.
- For multilane roundabouts, start by trying 16-foot-wide circulating lanes. Truck aprons are not typically needed on multilane roundabouts because trucks may intrude and use all lanes of the circulating roadway.
- If the central island is landscaped consider height restrictions for vegetation when there is a significant truck percentage. Because of slower acceleration and deceleration they may need to visually see opposing approach leg, not just the adjacent legs

**Comment [PR55]:** (per discussion with truck driver who negotiates City 2-lane RABs in Lacey Industrial Area served by Marvin Rd)

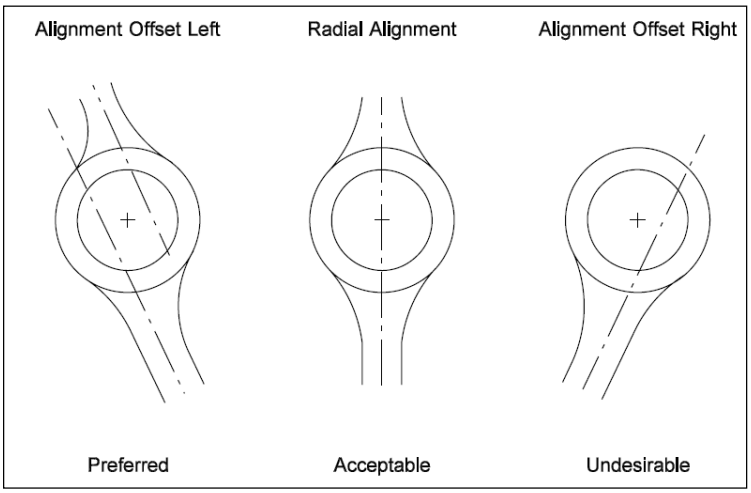
### (b) Approach Alignment

The desirable alignment of an approach leg to a roundabout is with the centerline passing to the left of the center of the circle (see Exhibit 1320-10). This alignment facilitates good entry deflection and entry curvature~~angle~~ on the approach~~es.~~ leg~~es~~. This reduces entry speeds and aligns entering vehicles into the circulating roadway, which is ~~key~~ essential to safety. An approach alignment offset to the right of the roundabout's center point is undesirable because it makes it more difficult to achieve adequate entry deflection. This could allow vehicles to enter the roundabout at a higher speed, which usually results in a reduction in safety.

When there are four or more approaches, it is desirable to equally space the angles between entries. When site conditions make equal spacing infeasible, evaluate the effect of closely spaced approaches on the roundabout operation.

When there are three approaches, it is desirable that they be ~~put~~ aligned into a tee configuration instead of a wye configuration. If ~~a~~an existing wye intersection is converted to a roundabout, attempt to orient the legs into the tee configuration~~.~~.

**Comment [PR56]:** Why? Is this alignment being proposed so the top of the tee carries the largest traffic volumes to avoid sum of critical movement occurring in a "L" shaped turning movement?




**Approach Leg Alignment**
***Exhibit 1320-10***

### (c) Entry

The entry is the most critical component of the roundabout. ~~The entry typically has a pedestrian refuge located one vehicle length (approximately 20 feet) back from the yield point. If provided, design the pedestrian refuge to meet the minimum ADA requirements.~~ The key to good entry design is an entry curve several vehicle lengths long that extends to the inside of the circulating roadway just offset from the truck apron. The entry curve (R1) needs to be long enough to promote a smooth natural drive path into the roundabout. The entry curve delineates the edge of the splitter island. (See Exhibit 1320-19 for splitter island details.)

In urban locations the length of the splitter island can be shorter in length and achieve the proper entry curve whereas in a rural high speed location longer splitter islands and reverse curves are needed to reduce speed prior to the entry curve. Typically, the higher the approach speed, the longer the splitter island.

In an urban location the entry typically has a pedestrian refuge located one vehicle length (approximately 20 feet) back from the yield point. Design the pedestrian refuge to meet the ADA requirements. In rural locations the placement of a pedestrian refuge island may not be required.

Prior to the pedestrian refuge, the minimum approach lane width is 12 feet. Widen the lane from this width until it matches the circulating lane width. Continuous curbing is needed on both sides of the entry roadway to achieve deflection and restrict the entry speed (see Exhibit 1320-19). ~~On high-speed approaches, consider using longer splitter islands and reverse curves to reduce speed prior to the entry. Typically, the higher the speed, the longer the splitter island.~~

**Comment [KS57]:** Should have a detail for this

**Comment [PR58]:** Is there a guideline similar to multiplying the 16-ft circulating width times the posted speed to determine an adequate taper for the splitter islands? Or is there a not less than X-feet for a typical symmetrical 2-lane approach?

### (d) Exit

The exit lane is designed to promote a smooth natural drive path ~~for a right-turning vehicle~~. The exit curve (R3) ~~starts at the central island where the entry curve to the left ends and extends past the pedestrian refuge to delineate the edge of the splitter island~~should provide a smooth transition towards the splitter island (see Exhibit 1320-13b, steps 5 and 6). Narrow the lane from the circulating roadway width past the pedestrian refuge to match with the ~~departing~~ exit lane (see Exhibit 1320-19). ~~Generally, the radius of the exit curve is larger than the entry curve to improve the ease of exit. A design that reduces the probability of a vehicle braking in the circulating lane or at the exit minimizes the likelihood of crashes at the exits. This larger radius does not translate into a faster speed when the exit speed is controlled by the circulating speed ($R_4$) plus acceleration to the exit crosswalk.~~Verify that there are no obstructions that hinder the line of sight to the back of the sidewalk near the curb ramp.

### (e) Central Island

The central island is a raised nontraversable area and may include a truck apron (see Exhibit 1320-20). The truck apron is the outer part of the central island, designed to allow for encroachment by the rear wheels of large trucks.

Design the texture and color of the truck apron pavement to be:

- Different from that of the circulating roadway so drivers can easily distinguish the difference.
- Different from that of the sidewalk pavement.

Use a roundabout truck apron cement concrete curb between the circulating roadway and the truck apron (see the *Standard Plans*).

Use roundabout center island cement concrete curb between the truck apron and the nontraversable area (see the *Standard Plans*). A 6-inch mountable cement concrete traffic curb may be substituted for the roundabout center island cement concrete curb, with justification, when oversized trucks might encroach on the nontraversable area of the central island.

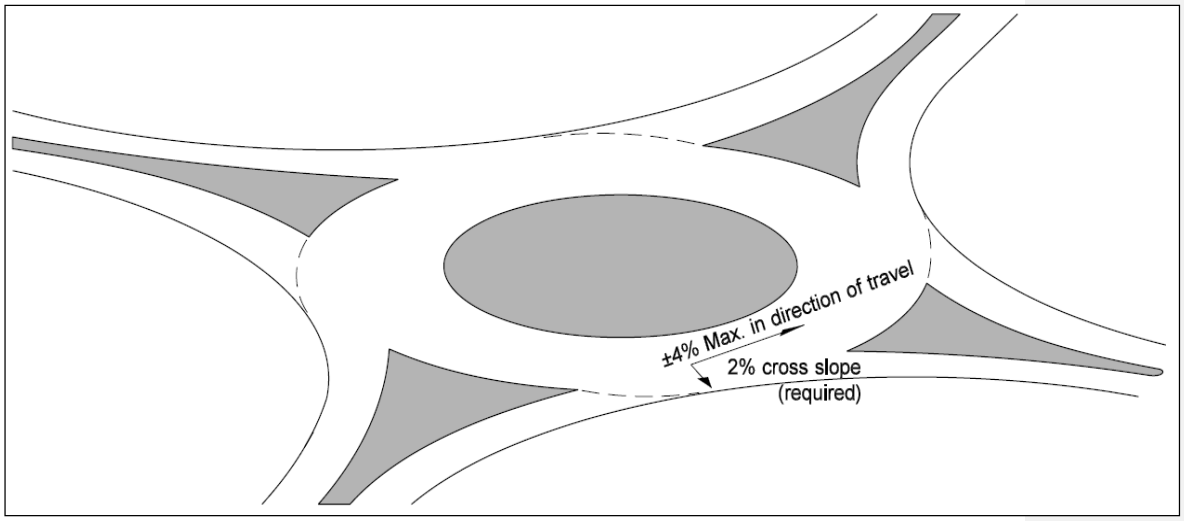
Landscape or mound the raised central island ~~to~~ four or five feet above the curbing to improve the visual impact of the roundabout to approaching drivers. When designing landscaping and objects in the central island, consider sight distance and roadside safety. Contact the region or HQ Landscape Architect for guidance. The central island is not a pedestrian area. Do not place street furniture or other objects (such as benches or monuments with small text) that may attract pedestrian traffic to the central island. Consider maintenance needs for access to the landscaping in the central island.

**Comment [PR59]:** (Consider height restrictions in locations where there is significant truck traffic so slow vehicle drivers can see opposite entry in addition to the adjacent entry?)

### (f) Superelevation and Grades

As a general practice, a cross slope of 2% away from the central island (negative 2% superelevation for circulating traffic) is used for the circulating roadway. Do not use a positive superelevation. If an approach has reverse curves, maintain the normal 2% crown away from the splitter island through the curves. The truck apron cross slope is equal to the 2% cross slope of the circulating roadway or may be increased to 3% (see Exhibit 1320-20).

The maximum allowable grade in the direction of travel along the circulating roadway is 4% (see Exhibit 1320-11). Grades in excess of 4% can result in increased difficulty slowing or stopping and a greater possibility of vehicle rollover. If the intersection is located on a steep slope, "bench" the roundabout to stay within this 4% maximum. When benching a roundabout, the minimum length of the approach landing is the length of the anticipated queue, but not less than 30 feet.




**Circulating Roadway Slope**
***Exhibit 1320-11***

### (g) Clear Zone

Clear zone criteria are based on the operating speeds determined by the vehicle's fastest paths ($R_1$ through $R_5$). Within the circulating roadway, the clear zone is measured from the edge of the traveled way on both the right and left side. The truck apron, if present, is included as part of the clear zone, not part of the traveled way. (See Chapter 1600 for clear zone details.) ~~When a 12-inch roundabout truck apron cement concrete curb is provided, additional clear zone in the central island is not needed.~~

**Comment [KS60]:** Where did this come from? Can this be deleted or made to affixed say 10 ft or less?

### (h) Sight Distance

At roundabouts, provide stopping sight distance and intersection sight distance. Along with the intersection sight triangle distances described below, provide vertical sight distance as well (see Chapter 1260). Momentary sight obstructions that do not hide vehicles or pedestrians, such as poles and signposts, are acceptable in the intersection sight triangles.

Stopping sight distance is calculated and measured using the guidance given in Chapter 1260.

**Comment [KS61]:** Conflict with

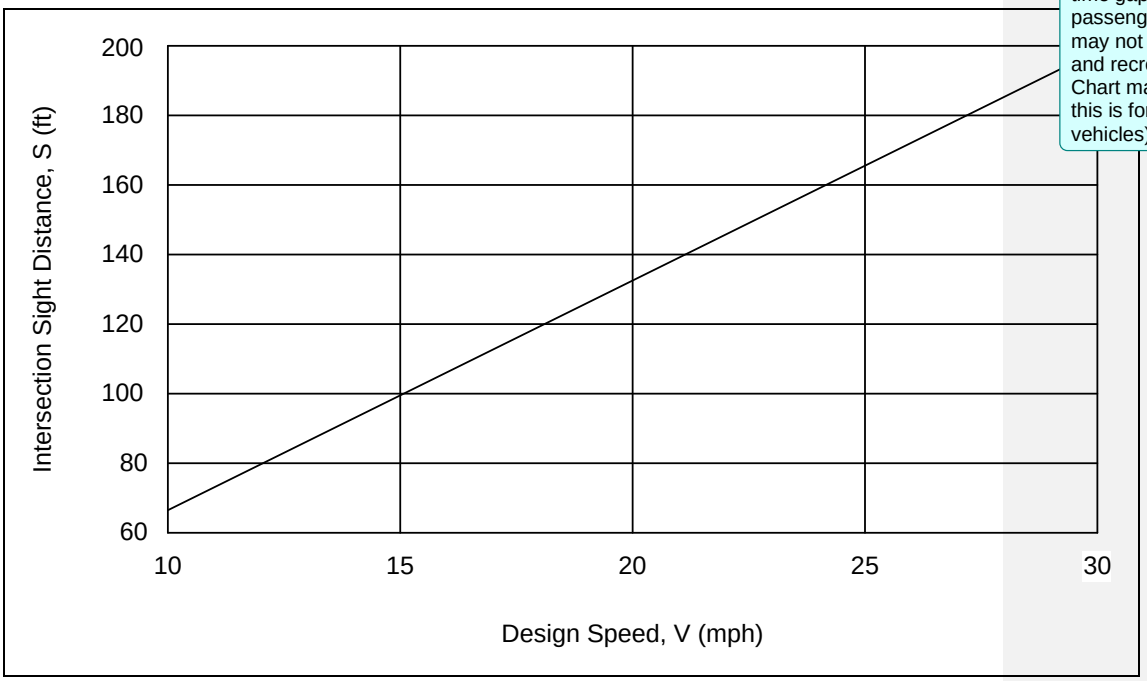
Three critical types of locations need to be evaluated for stopping sight distance:

- Approach stopping sight distance to crosswalk (see Exhibit 1320-21).

- Stopping sight distance on the circulatory roadway (see Exhibit 1320-22).
- Stopping sight distance to crosswalk on the exit (see Exhibit 1320-23).

For intersection sight distance at roundabouts, provide entering vehicles a clear view of traffic on the circulating roadway and on the immediate upstream approach in order to judge an acceptable gap (see Exhibit 1320-24). The intersection sight distance at roundabouts is given in Exhibit 1320-12. The $S_1$ intersection sight distance is based on the average of the $R_1$ and $R_2$ speeds, the $S_2$ intersection sight distance is based on the $R_4$ speed. The sight distance may also be calculated using the intersection's sight distance equation given in Chapter 1310 using a time gap ($t_g$) of 4.5 seconds.

**Comment [PR62]:** (This time gap appears okay for passenger vehicles, but may not be good for trucks and recreational vehicles. Chart may need to indicate this is for passenger vehicles).




**Speed vs. Intersection Sight Distance**
***Exhibit 1320-12***

For roundabouts, these distances are assumed to follow the curvature of the roadway, thus are not measured as straight lines but as distances along the vehicular path. The entering vehicle driver needs to determine whether a gap is acceptable 50 feet before reaching the yield point. Research has determined that excessive intersection sight distance results in a higher crash frequency. The 50-foot distance is intended to slow vehicles prior to entering the roundabout, which allows them to focus on the pedestrian crossing prior to entry. It may be advisable to add landscaping to restrict sight distance to the minimum. Exhibit 1320-25 combines stopping and intersection sight distances to identify landscaping height restrictions.

### (i) Right-Turn Slip Lane

If a capacity analysis shows a heavy right-turn volume, consider using a right-turn slip lane. Right-turn slip lane fastest paths are measured as a right turn ($R_5$) plus acceleration to the merge point. Two ways to terminate a right-turn slip lane are: as a merge (lane drop) or as a yield (see Exhibit 1320-26). Verify that stopping sight distance for pedestrians is met. When present, m~~M~~ake pedestrian refuge islands included with right-turn slip lanes ADA compliant (see Chapter 1510).

### (j) Add and Drop or Bypass Lanes

When a lane is added prior to a roundabout entry to accommodate traffic volume, it can be much shorter than what is normally needed at a signal. Instead of the add lane needing to store enough vehicles to maintain two lanes of saturation flow during the signal's green time, the roundabout add lane only needs to be long enough to provide access to gaps in all circulating lanes as they become available (see Exhibit 1320-27). The same principle applies to drop lanes where additional lanes are provided at a roundabout exit. Instead of two dense platoons needing distance to spread out and merge downstream of a signal, vehicles exiting a roundabout are usually more evenly spaced, making merging easier and requiring less distance before beginning the taper (see Exhibit 1320-27). A practical way to end or drop the lane as it transitions from two exit lanes to one exit lane is to taper each lane symmetrically in order to indicate to drivers that the left exit lane is not prioritized over the other (right) exit lane. This type of lane strategy improves lane utilization for multilane roundabouts in both the entry and exit areas and the circulating roadway.

### (k) Railroad Crossings

Although it is undesirable to locate any intersection near an at-grade railroad crossing, a crossing is acceptable near a roundabout as long as the roundabout does not force vehicles to stop on the tracks. The distance between the yield point and the tracks is sized to at least accommodate the design vehicle length, unless there is a gate on the circulating roadway that allows the roundabout entry to clear prior to the train's arrival (see Exhibit 1320-28).

The intersection analyses and site-specific conditions help determine the need for, and optimum placement of, a gate on the circulating roadway. Exhibit 1320-28 shows two example locations for railroad gates on the circulating roadway, however only one would be used. While a roundabout has a tendency to lock up as soon as the gates come down on the circulating roadway, the affected leg is very efficient at returning to normal operation.

### (l) Curbing

The use of the proper type of curbing in and around the roundabout is important consideration. Vertical faces on curbing have damage tires if the vehicle has to traverse over a curb in order to drive through the roundabout In areas where large tucks are present or where the occasional oversized vehicle may have to navigate through a roundabout proper special consideration needs to be made on curb types used and their locations. Several alternative types of curbing that are rolled or tapered face have been developed for use in these types of situations.

**Comment [KS63]:** Delete?

**Comment [PR64]:** Consider using Exhibit 1310-12a, 1301-12b, and 1310-7 for determining minimum storage lengths when there are significant truck percentages present. The add and drop storage lane lengths may need to be longer depending on how posted speed and Truck % influence lane utilization and storage. Bottom line is that a 100-ft minimum is likely to be too short to achieve even distribution over 2-lane approach and receiving lanes)

## 1320.07 Pedestrians

Pedestrian crossings at roundabouts are unique in that the pedestrian crosses at a point behind the first vehicle waiting at the yield point. When pedestrian activity is anticipated, include a pedestrian refuge in the splitter island and mark all pedestrian crosswalks. Position the crosswalk one car length (approximately 20 feet) from the yield point and perpendicular to the entry and exit roadways (see Exhibit 1320-21). Consider landscaping strips to discourage pedestrians crossing at undesirable locations. Where possible, provide a buffer between the traveled way and sidewalk.

Provide a barrier-free passageway at least 10 feet wide (desirable) through all islands and buffers. Whenever a raised splitter island is provided, provide a 6-foot island width for pedestrian refuge (measured from back of curb to back of curb). This facilitates pedestrians crossing in two separate movements.

**Comment [KS65]:** Should this be 7 ft in order to provide a 2'+- gap between the DWS on each side

Give special attention to assisting visually impaired pedestrians through design elements, such as providing truncated domes for tactile cues at curb ramps and splitter islands. Provide appropriate informational cues to pedestrians regarding the location of the sidewalk and the crosswalk.

For additional information on sidewalk ramps and pedestrian needs, see Chapter 1510.

## 1320.08 Bicycles

In most cases, the operating speed of vehicles within roundabouts is similar to the speed of bicyclists, and both can use the same roadway without conflict or special treatment. Less experienced cyclists may not feel comfortable riding with traffic and may want to use a sidewalk instead. End marked bicycle lanes or shoulders before they enter a roundabout in order to direct bicycles to either enter traffic and use the circulating roadway or leave the roadway onto a separate shared-use path or shared-use sidewalk. When using a shared-use sidewalk, the width is the same as a separate shared-use path. (See Exhibit 1320-29 for the recommended design for ending a bicycle lane with a shared-use sidewalk at a roundabout and Chapter 1520 for shared-use path widths.)

## 1320.09 Signing and Pavement Marking

**Comment [KS66]:** Need recommendations from Ed Lagergren.

A typical roundabout sign layout is shown in Exhibit 1320-30. A diagrammatic guide sign, as shown in the exhibit, can be used to provide the driver with destination information. Provide a route confirmation sign on state routes shortly after exiting the roundabout, but after the pedestrian crossing (if there is one) so that the sign will not distract drivers from watching for pedestrians. For multilane roundabouts, provide a lane use sign after the directional sign, but far enough before the crosswalk that changing lanes will not distract drivers from watching for pedestrians. If there is an add lane and it is short enough, it is desirable to place the lane use sign prior to the add lane to cut the number of lane changes.

Provide pavement markings to reinforce appropriate lane use adjacent to the lane use sign if there are two lanes at that point; otherwise, at the point at which there are two lanes and in the circulating roadway where appropriate. If lane use markings are used in the circulating roadway, make them visible to vehicles from the yield point. Contact the region or HQ Traffic Office for additional information when completing

the channelization plan for a roundabout. Examples of pavement marking layouts for single and multilane roundabouts are shown in Exhibit 1320-31. For additional details on signing and pavement marking, see the MUTCD.

A roundabout sign plan is developed to identify existing and proposed signing on state highways and is reviewed by the region Traffic Engineer. Roundabout sign plans on the state routes are to be furnished to the HQ Traffic Office for review and concurrence. The plan provides an easily understood graphic representation of the signing and to provide statewide uniformity and consistency for regulatory, warning, and guide signs at roundabouts on the state highway system. The roundabout sign plan is reviewed and approved by the region Traffic Engineer.

**Comment [PR67]:** From the HQ Traffic office.

## 1320.10 Illumination

Provide illumination for each of the conflict points between circulating and entering traffic in the roundabout and at the beginning of the raised splitter islands. Illuminate raised channelization or curbing. Position the luminaires on the downstream side of each crosswalk to improve the visibility of pedestrians. Light the roundabout from the outside in toward the center. This improves the visibility of the central island and circulating vehicles to motorists approaching the roundabout. Ground-level lighting within the central island that shines upward toward objects in the central island can also improve their visibility. Exhibit 1320-32 depicts the light standard placement for a four-leg roundabout. (For additional information on illumination, see Chapter 1040.)

Consider installing temporary illumination during the construction of the roundabout to provide advanced warning to approaching drivers and adequate lighting through the staged construction work zone.

## 1320.11 Access, Parking, and Transit Facilities

No road approach connections to the circulating roadway are allowed at roundabouts unless they are designed as legs to the roundabout. It is desirable that road approaches not be located on the approach or departure legs within the length of the splitter island. The minimum distance from the circulating roadway to a road approach is controlled by corner clearance using the outside edge of the circulating roadway as the crossroad (see Chapter 5450). If minimum corner clearance cannot be met, provide justification. (For additional information on limited access highways, see Chapter 530.)

If the parcel adjoins two legs of the roundabout, it is acceptable to provide a right-in/right-out driveway within the length of the splitter islands on both legs. This provides for all movements; design both driveways to accommodate their design vehicle (see Exhibit 1320-33a).

Roadways between roundabouts may have restrictive medians with left-turn access provided with U-turns at the roundabouts (see Exhibit 1320-33b).

Parking is not allowed in the circulating roadway or on the entry or exit roadway within the length of the splitter island.

Transit stops are not allowed in the circulating roadway, in the approach lanes within the length of the splitter island, or in the exit lanes prior to the crosswalk. Locate transit stops on the roadway before or after the roundabout, in a pullout or where the

pavement is wide enough that a stopped bus does not block the through movement of traffic or impede sight distance.

## 1320.12 Design Procedures

Document roundabout design considerations and conclusions in accordance with Chapter 300.

### *(1) Conceptual Design*

Early coordination between the design team, region Traffic and Project Development offices, and HQ Traffic and Design offices is essential for a roundabout design layout.

#### (a) Conceptual Meeting

Conduct a Conceptual Meeting with the region Traffic Office, the region Project Development Engineer or Engineering Manager, and the HQ Traffic and Design offices after the traffic analysis has been completed. The intent of this meeting is to review, discuss, and evaluate alternative layouts for a roundabout before too much time and resources have been expended. The outcome of the meeting will provide sufficient information that a designer can proceed with finalizing the geometric design.

As a minimum, consider, discuss, and document the following items for the Conceptual Meeting:

1. **Project Overview**
2. **Traffic Analysis Recommendations and Conclusions**

   In addition to Chapter 320, Traffic Analysis, the following items need to be documented:

   - Use 20 years after the year construction is scheduled to begin as the design year of the analysis.
   - Identify the approximate year a single-lane roundabout intersection level of service (LOS) will operate below the selected design LOS or require expansion.
   - Identify and justify growth rate(s) used for the design year analysis.
   - Provide peak hour (both a.m. and p.m.) turning movement volumes for each leg for the existing and design year.
   - Input an environmental factor of 1.1 if required by the analysis software.
   - Provide pertinent reports generated (such as level of service, queue length, delay, percent stopped, and degree of saturation) from the analysis software used. (Contact the region or HQ Traffic Office for currently approved capacity analysis software. Using older software versions is not acceptable).
   - Provide explanation of the impacts to traffic operations upstream and downstream of the intersection in situations where V/C exceeds 0.92.

3. **Preliminary Layout**

Provide an existing plan sheet, base map, or aerial photo (non-CADD-generated is encouraged) with the preliminary roundabout sketched at the intersection for use in evaluating current or new concepts to the roundabout layout. The intent is for the designer to quickly develop the roundabout footprint for the intersection without expending a lot of time or resources drafting PS&E-quality plans to show the design of the roundabout. Typically, revisions are needed based upon the feedback received at the Conceptual Meeting.

Use an existing plan sheet, base map, or aerial photo of sufficient scale to show existing roadway alignment and features, surrounding topographic information (may include aboveground and belowground utility elements), rights of way (existing), surrounding buildings, environmental constraints (such as wetlands), drainage, and other constraints that may impact the design of the roundabout.

**4. Design Vehicle**

Identify the design vehicle for each leg of the intersection. Include the truck types and sizes (oversized vehicles) that travel through the area (currently and in the future) and whether the roundabout is on an existing or planned truck route.

**5. Other Topics for Discussion**

Additional items that need to be discussed and considered in the design of the roundabout may include:

- Vehicle turning path templates: Use approved software to validate the roundabout.
- Fastest path speeds.
- Splitter island design: Provide a smooth entry alignment into the roundabout.
- Other roundabout shapes.
- Bike and pedestrian design, including ADA requirements.
- Central island design.
- Curbing details.
- Signing, illumination, and delineation considerations.
- Vertical grade.
- Adjacent posted speeds.
- Existing and future corridor congestion.

## *(2) Geometric Design*

The Design Documentation Package (DDP) is the documentation of the final roundabout design and the decisions that resulted in the design. Complete the DDP before intersection plan approval.

As a minimum, include the following items in the geometric Design Documentation Package:

(a) Intersection plan showing the roundabout channelization.

(b) A summary of the design decisions and deviations that pertain to the roundabout.

(c) Roundabout geometric data, including the following:

- Identify approach design speeds for all approach legs.
- Identify the design vehicle.
- Provide a table summarizing the roundabout design details, including inscribed diameter, central island diameter, truck apron width, fastest path (radius and speed) for each approach, and superelevation of the circulating roadway.
- Provide detailed drawings showing the fastest paths for each movement.
- Provide a table summarizing stopping and intersection sight distance on each leg.
- Provide auto turn paths showing design vehicle, WB-67, and largest oversize vehicle movements.

(d) Detailed drawings of the splitter islands on each leg.

(e) Preliminary signing, delineation, and illumination plans.

(f) Curb types used.

(g) Central island design.

(h) Bike and pedestrian design, including ADA requirements.

A roundabout review checklist and example package is located on the Project Development web page: www.wsdot.wa.gov/design/projectdev

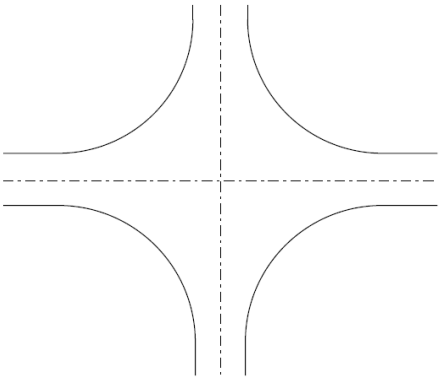
### *(3) Approvals*

A roundabout is approved as an intersection in accordance with Chapter 1310. Document all design decisions as part of the Design Documentation Package (DDP).

If there are numerous design variances for a roundabout design, coordinate with the region Traffic Office, region Project Development Engineer or Engineering Manager, and Assistant State Design Engineer to determine whether a project analysis is needed.

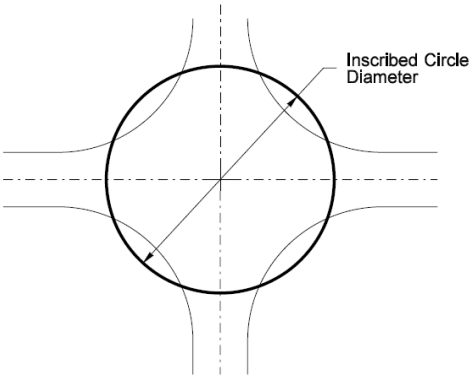
## 1320.13 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist: www.wsdot.wa.gov/design/projectdev/



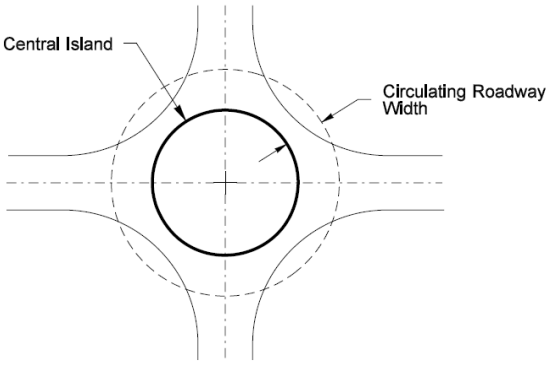
Step 1

**Step 1**
Start with a scale drawing of the intersection.




Step 2

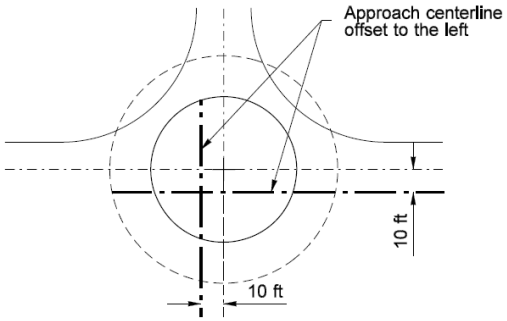
**Step 2**
Select a trial inscribed circle diameter based on the capacity analysis and Exhibit 1320-8 and place this at the intersection.




Step 3

**Step 3**
Establish the central island and circulating roadway width.

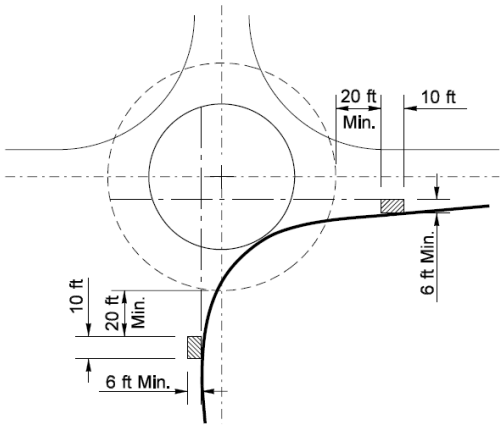
**Design Iteration Steps**
***Exhibit 1320-13a***




Step 4

**Step 4**

Draw each approach's centerline 10 feet to the left of the center of the circle.

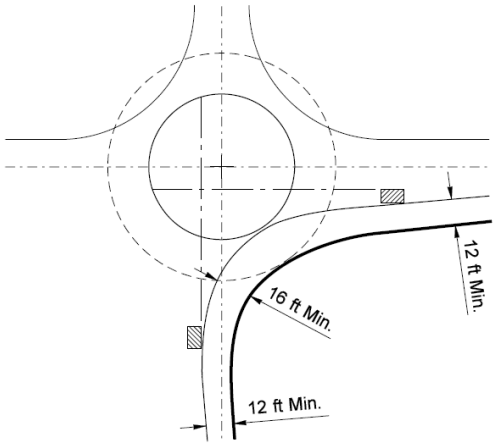



Step 5

**Step 5**

Draw a 10-foot x 6-foot-wide (back of curb to back of curb) pedestrian refuge 20 feet from the inscribed circle centered on the leg's centerline.

Draw the design elements of the entry curve and the next exit curve to the right. Start with the entry and exit that are closest together and continue around the circle until completing the exit curve on the initial approach.




Step 6

**Step 6**

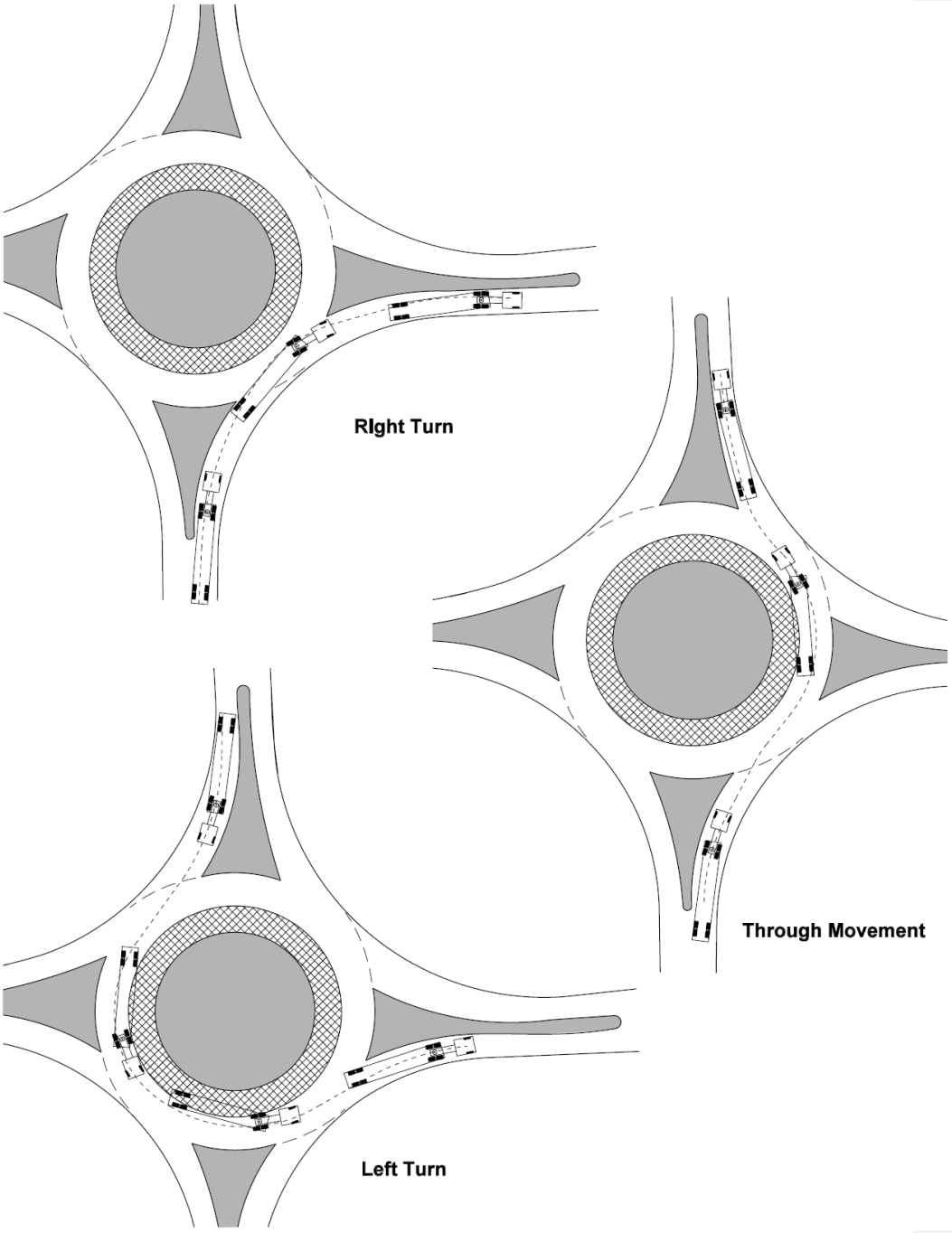
Evaluate the adequacy of the roundabout design (check vehicle turning path templates, entry angle, fastest paths, and natural vehicle paths).

Revise deficient design element(s), repeating the design steps above until design performance objectives are met.

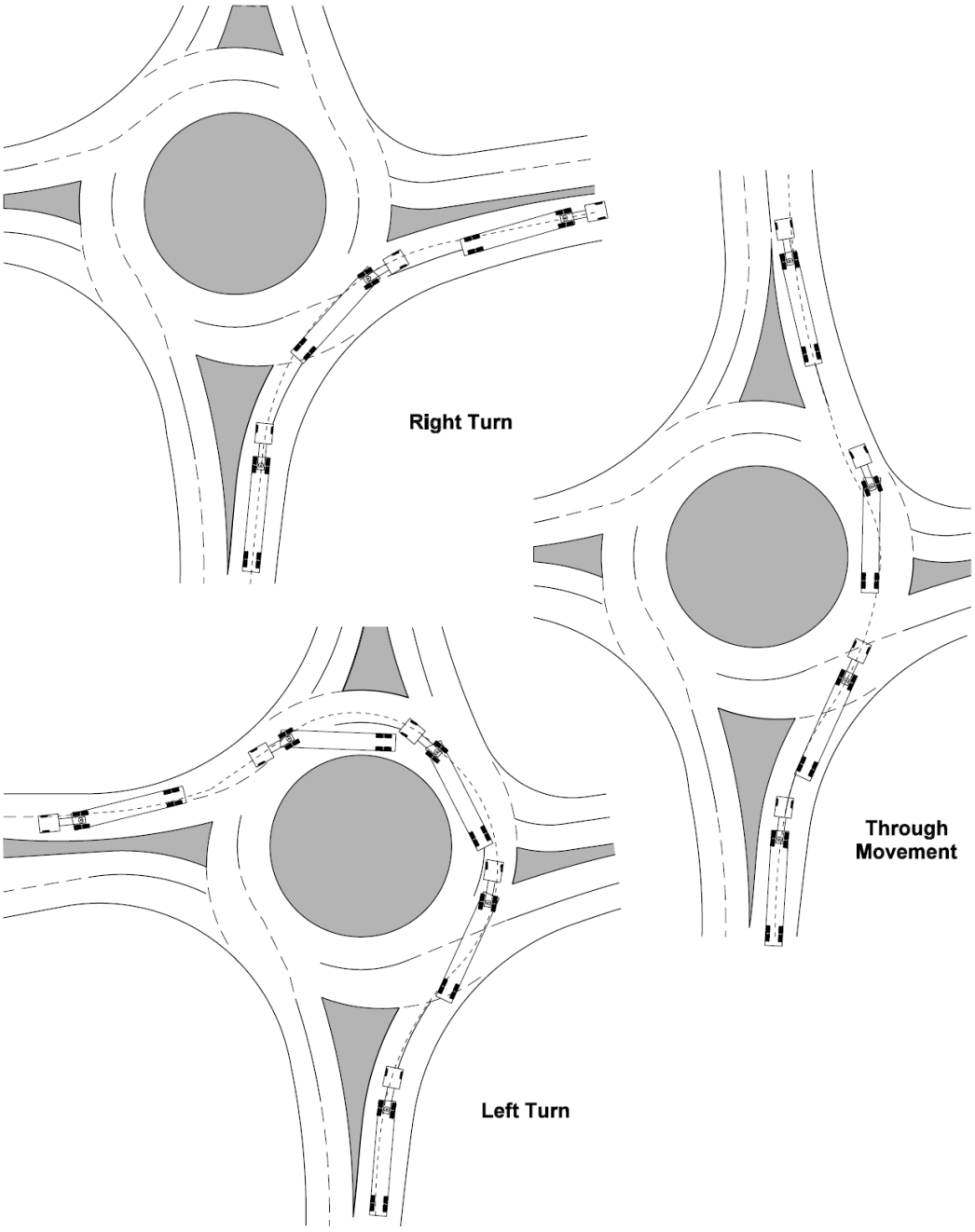
Pedestrian Refuge Area

**Design Iteration Steps**

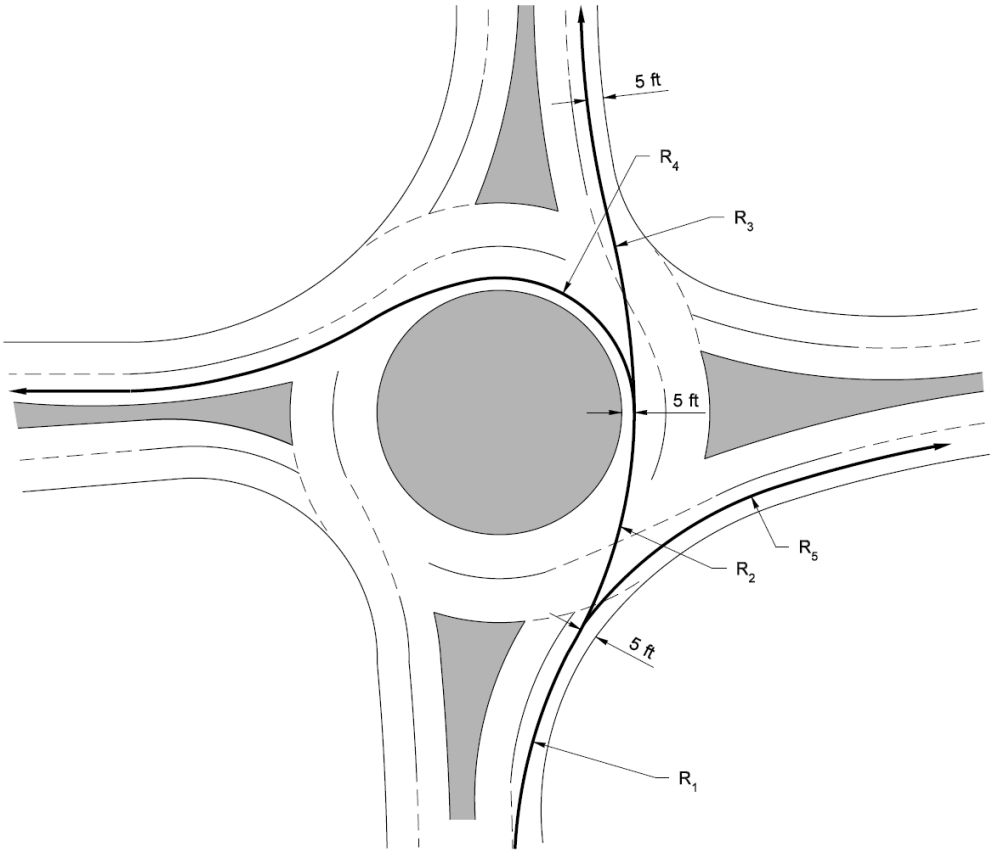
***Exhibit 1320-13b***




**Truck Turning Paths**
***Exhibit 1320-14a***




**Truck Turning Paths**
***Exhibit 1320-14b***



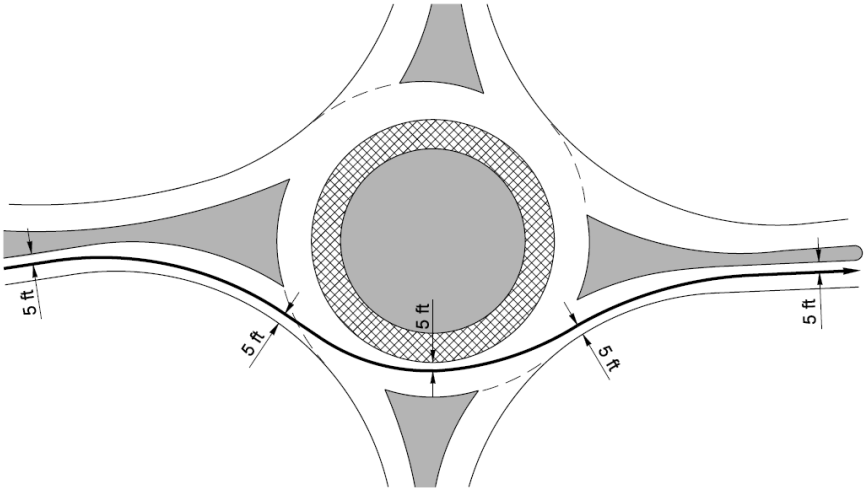

**Where:**

$R_1$ = Entry path radius
$R_2$ = Circulating path radius
$R_3$ = Exit path radius
$R_4$ = Left-turn path radius
$R_5$ = Right-turn path radius

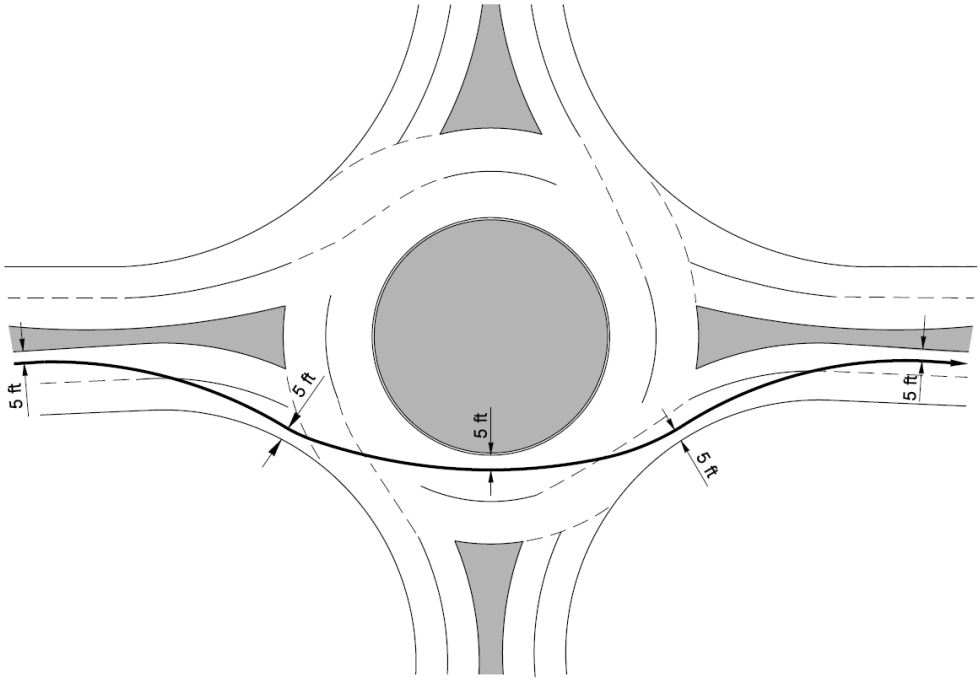
**Notes:**

- The 5-ft clearance is from raised curbing.
- Edge striping next to a curb is discouraged.

**Fastest Path Radii**
***Exhibit 1320-15a***

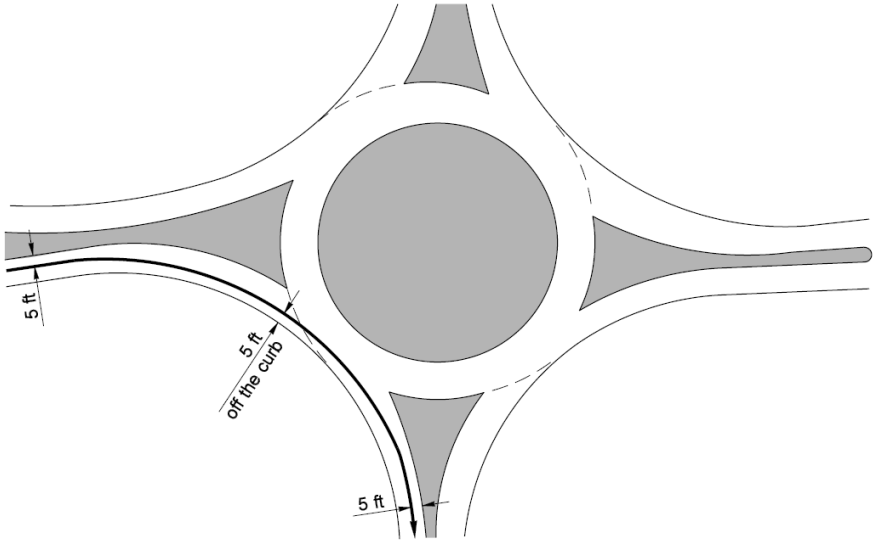



**Single-Lane Roundabout**

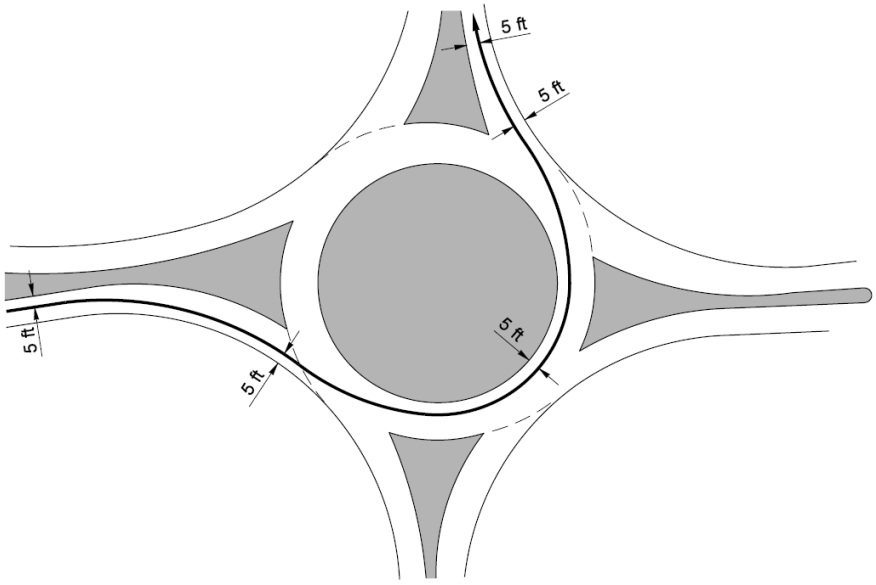



**Multilane Roundabout**

**Fastest Path Radii**
***Exhibit 1320-15b***

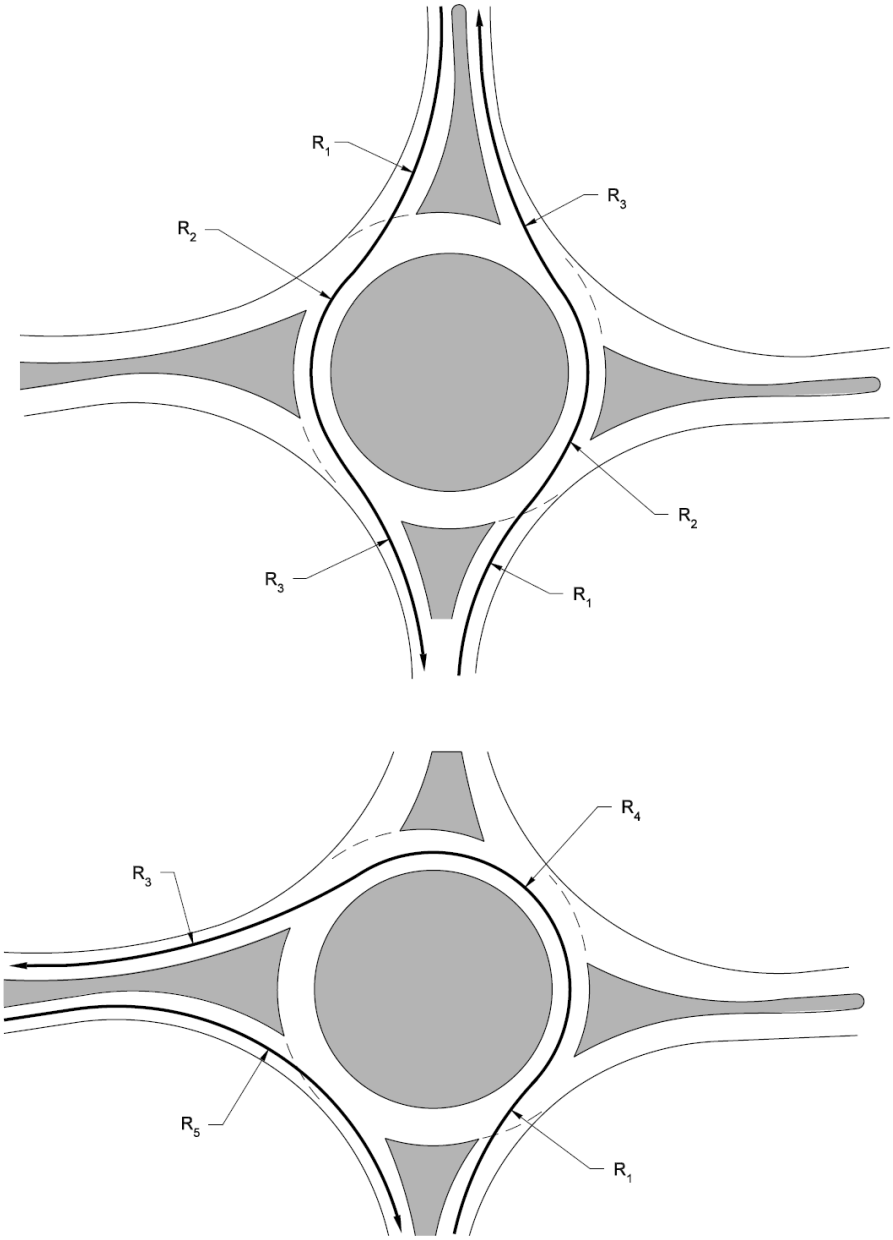



**Right-Turn Movement**

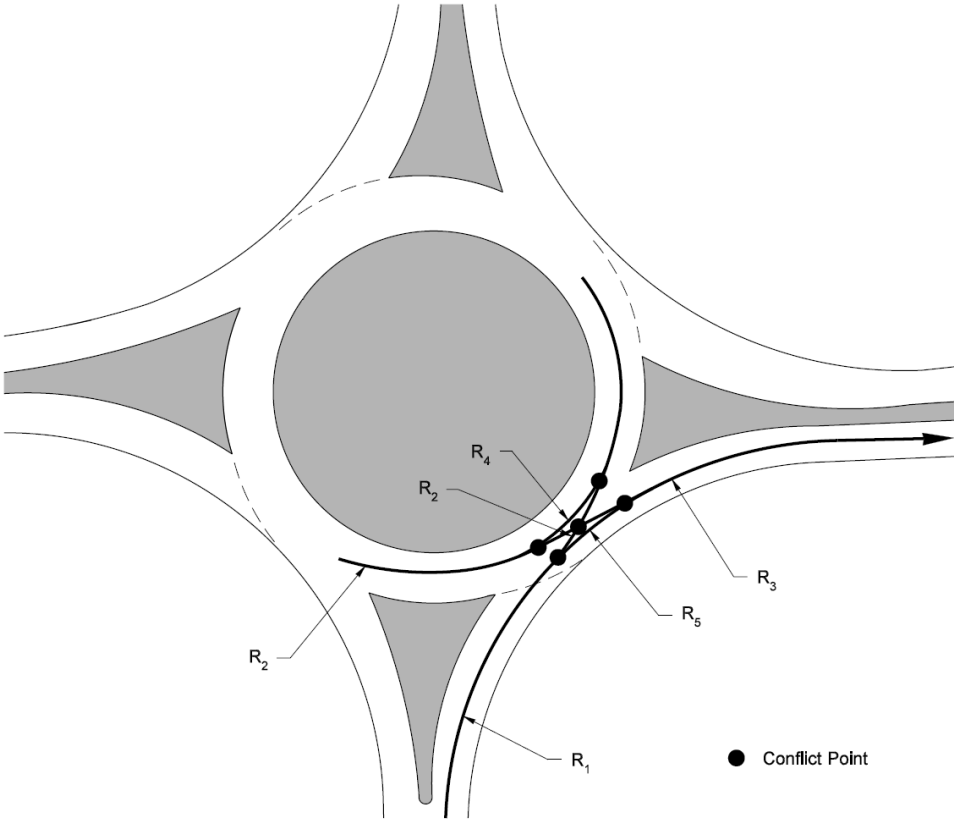



**Left-Turn Movement**

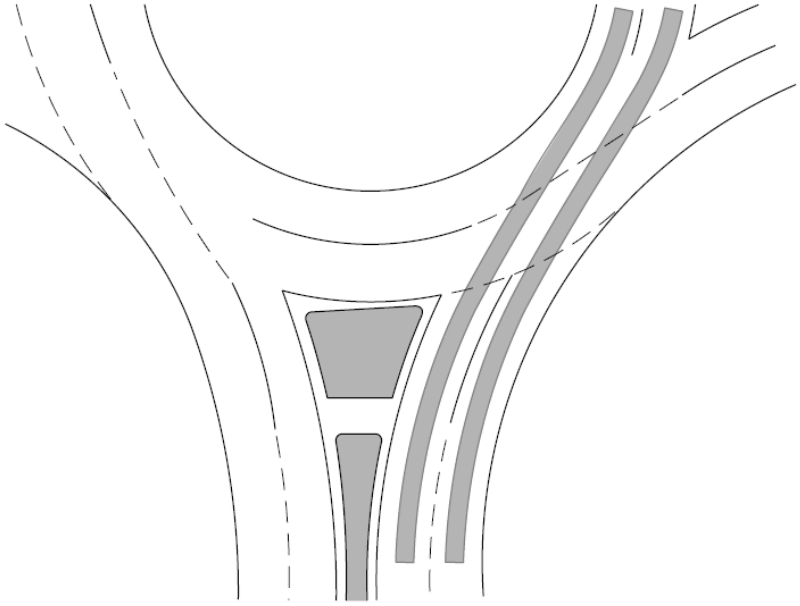
**Fastest Path Radii**
***Exhibit 1320-15c***



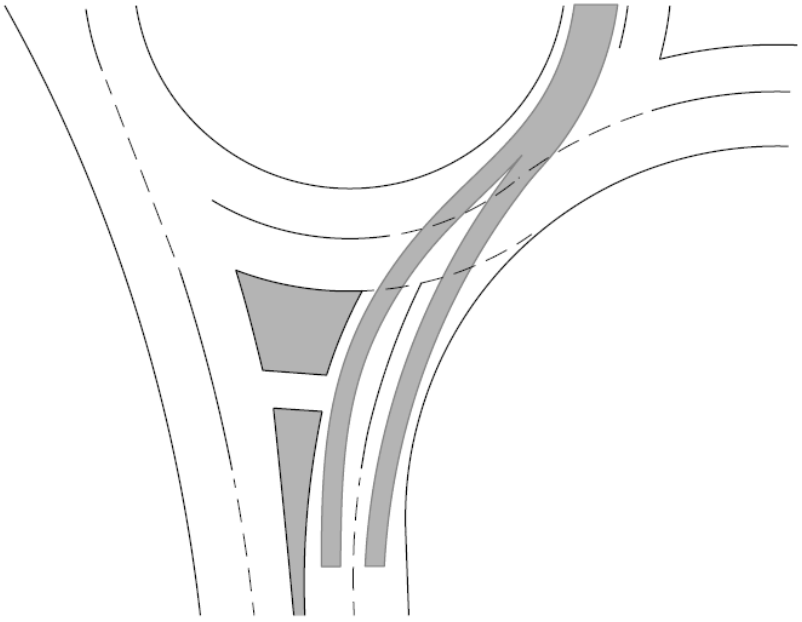

**Consecutive Radii**
***Exhibit 1320-16***




**Coinciding Radii and Conflict Points**
***Exhibit 1320-17***

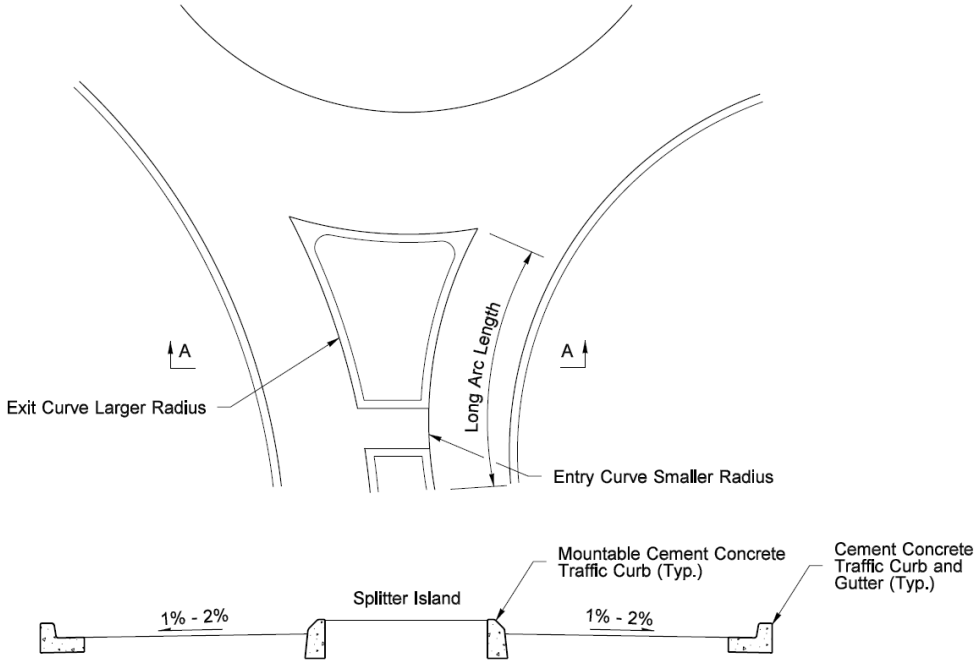


**Entry Design Without Path Overlap (Desirable)**



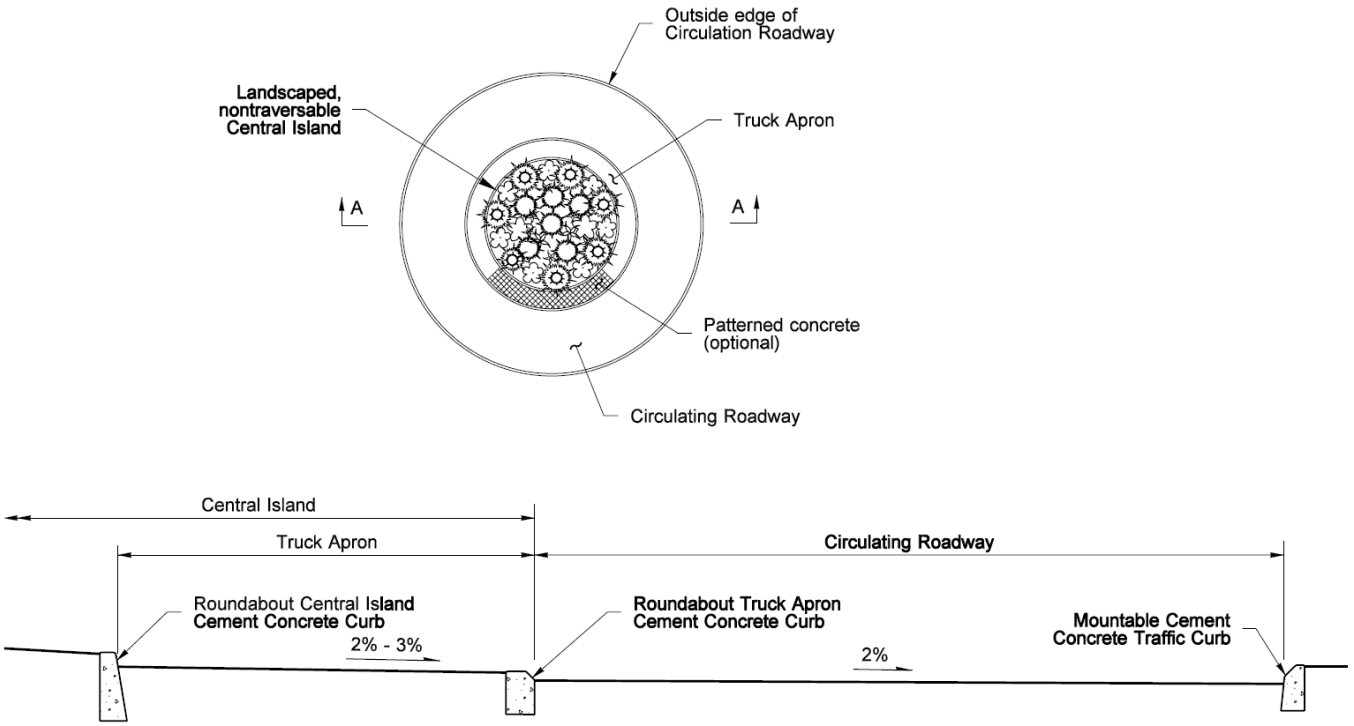
**Entry Design With Path Overlap (Undesirable)**

**Entry Design Path**
***Exhibit 1320-18***




**Section A-A**
(not to scale)

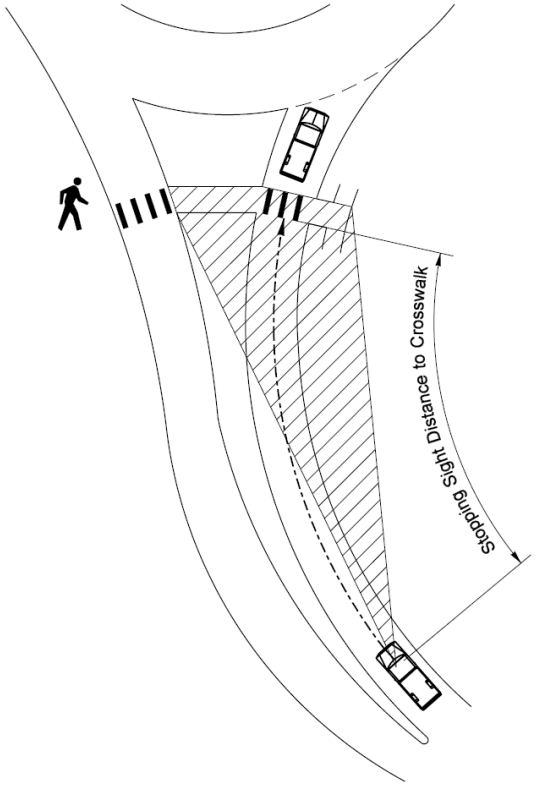
**Entry and Exit Curves**
***Exhibit 1320-19***




**Section A-A**
(not to scale)

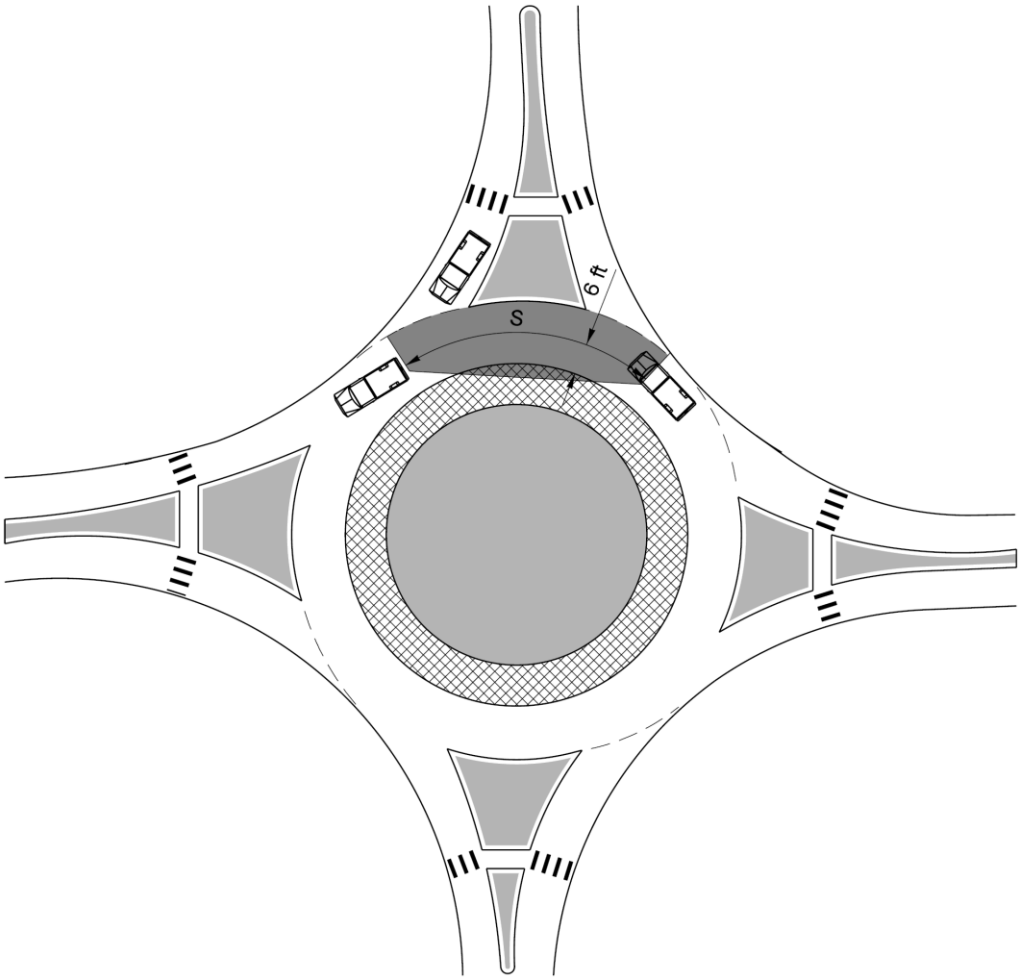
**Note:**
For roundabout curb details, see Cement Concrete Curbs in the *Standard Plans*.

**Central Island and Cross Section**
***Exhibit 1320-20***

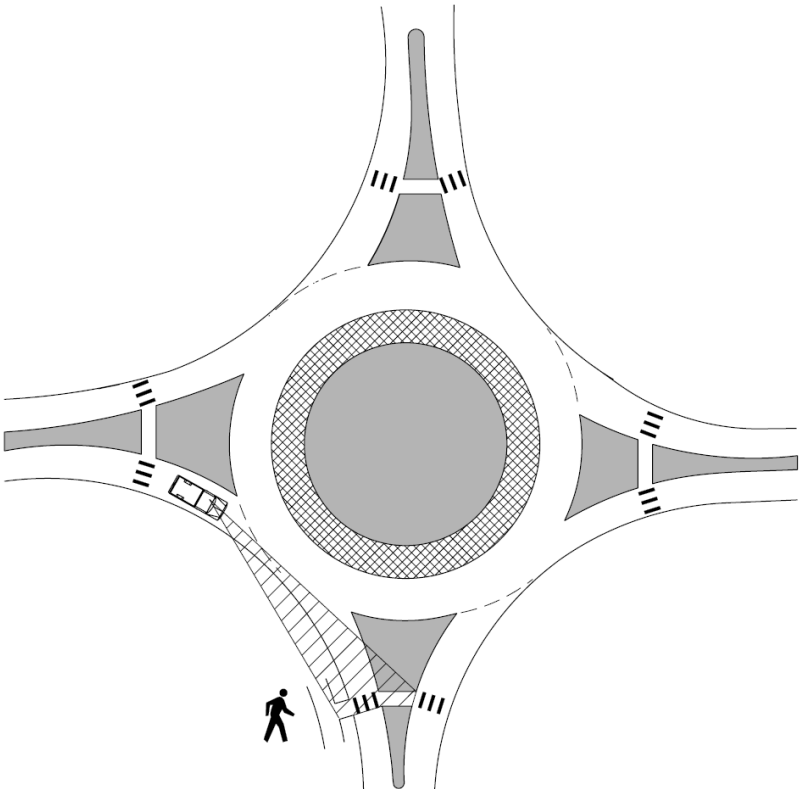



**Note:**
Position the crosswalk one car length (approximately 20 feet) in advance of the yield point.

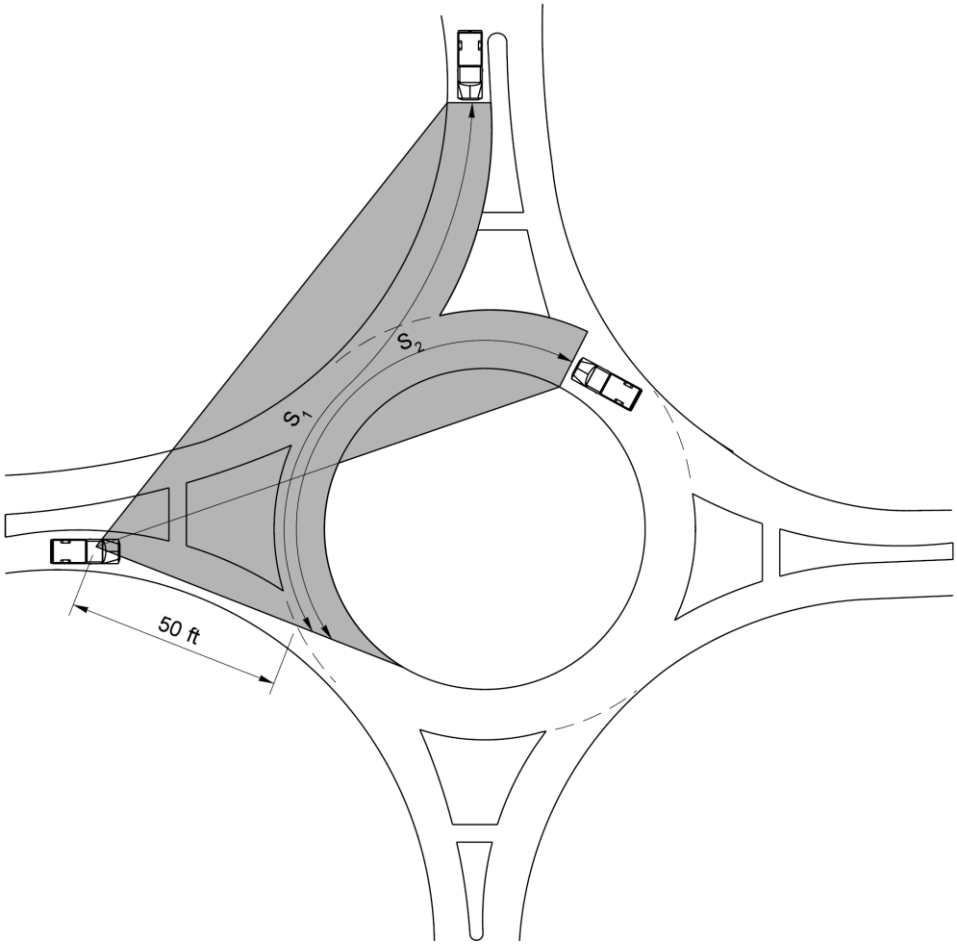
**Approach Stopping Sight Distance to Crosswalk**
***Exhibit 1320-21***




**Stopping Sight Distance on Circulatory Roadway**
***Exhibit 1320-22***



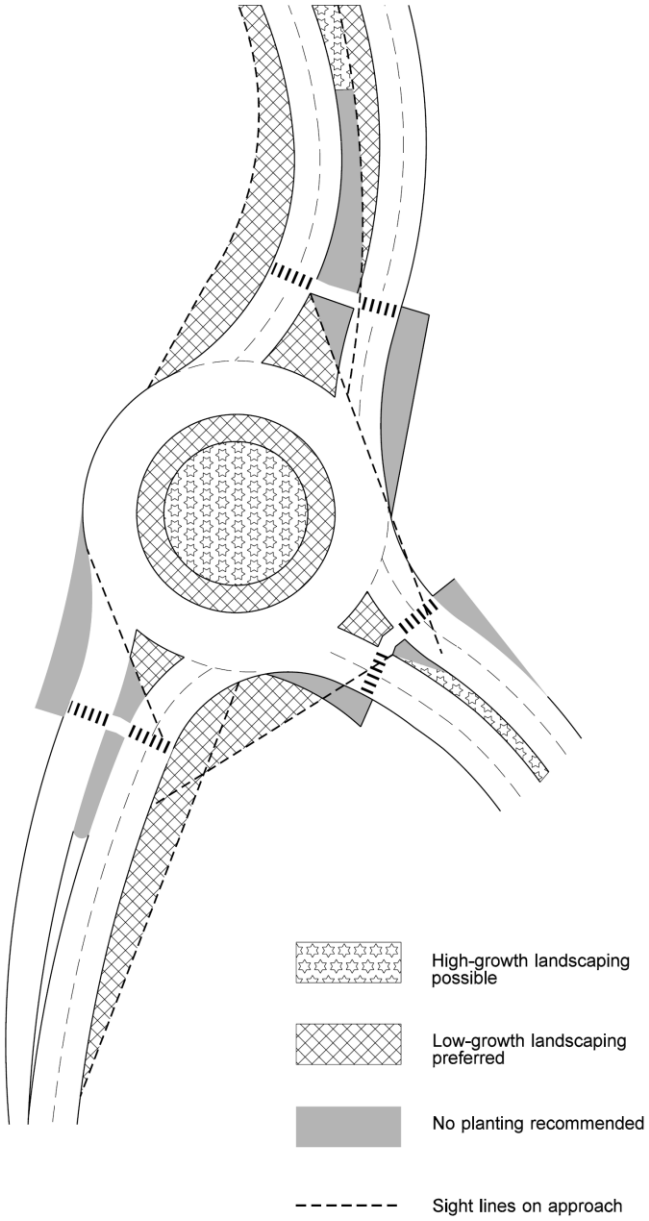
**Exit Stopping Sight Distance to Crosswalk**
***Exhibit 1320-23***



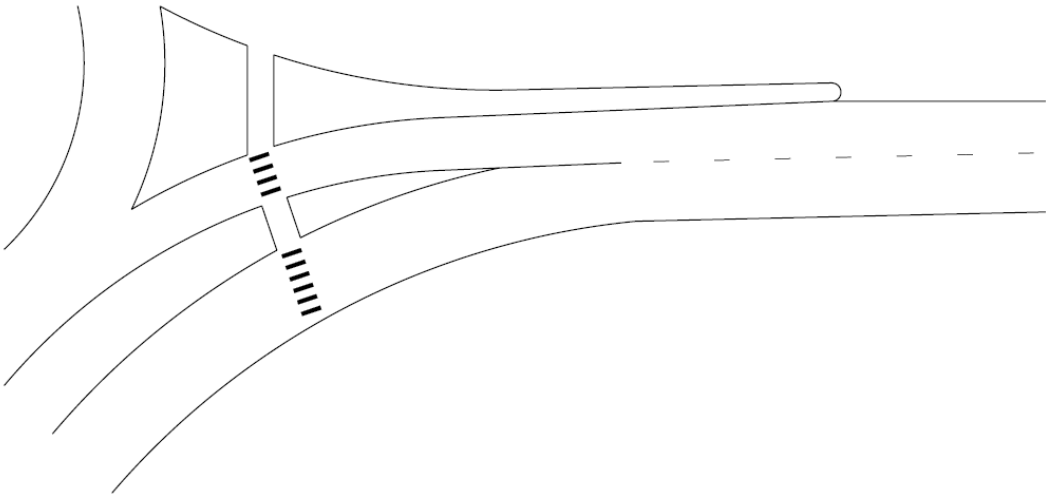

$S_1$ = Entering stream sight distance
$S_2$ = Circulating stream sight distance

**Intersection Sight Distance**
***Exhibit 1320-24***

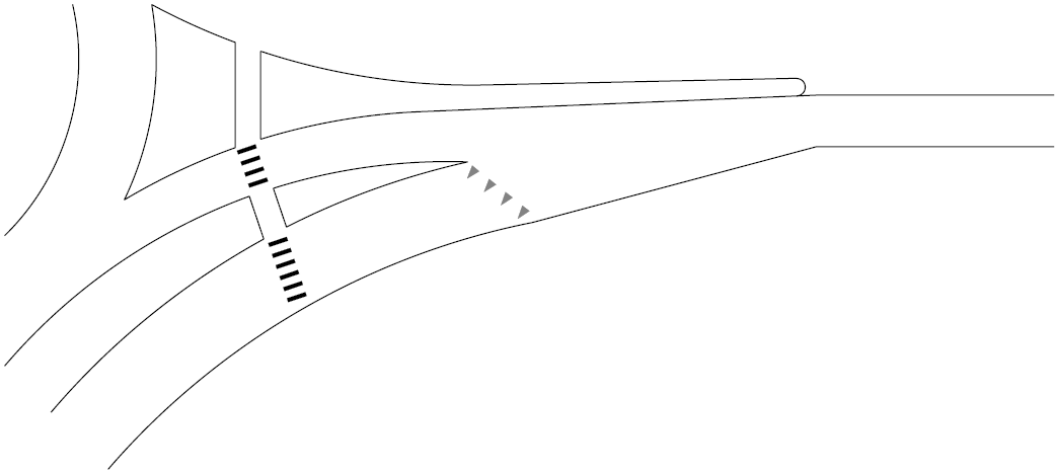
**Comment [TWF68]:** (WS DOT?) for Passenger Vehicles (Consider ability to see opposing entry for locations with significant Truck and Recreational Vehicle percentages)




**Landscaping Height Restrictions for Intersection Sight Distance**
***Exhibit 1320-25***

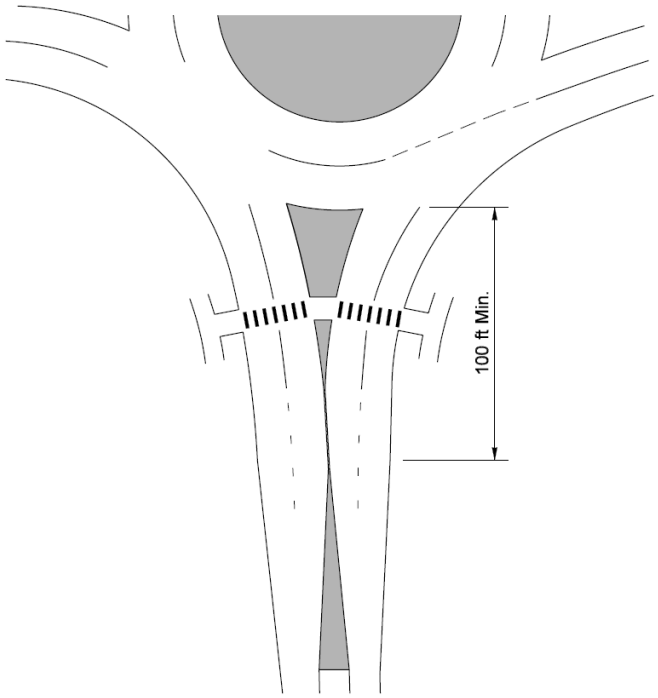


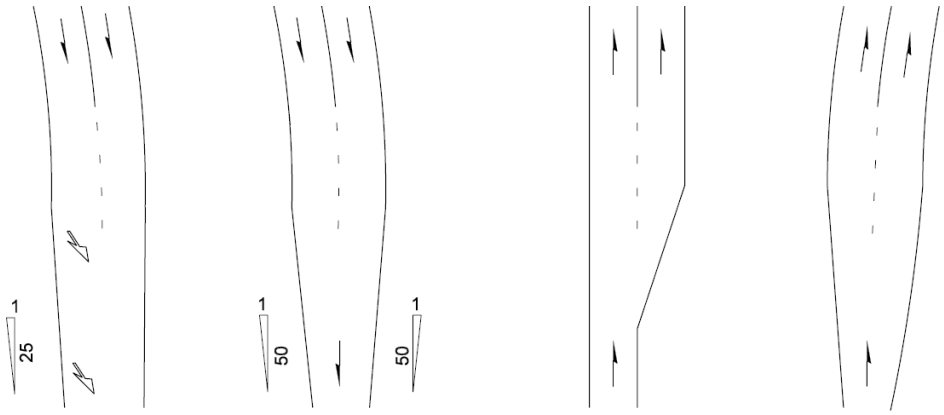
**Merge Termination**



**Yield Termination**

**Right-Turn Slip Lane Termination**
***Exhibit 1320-26***

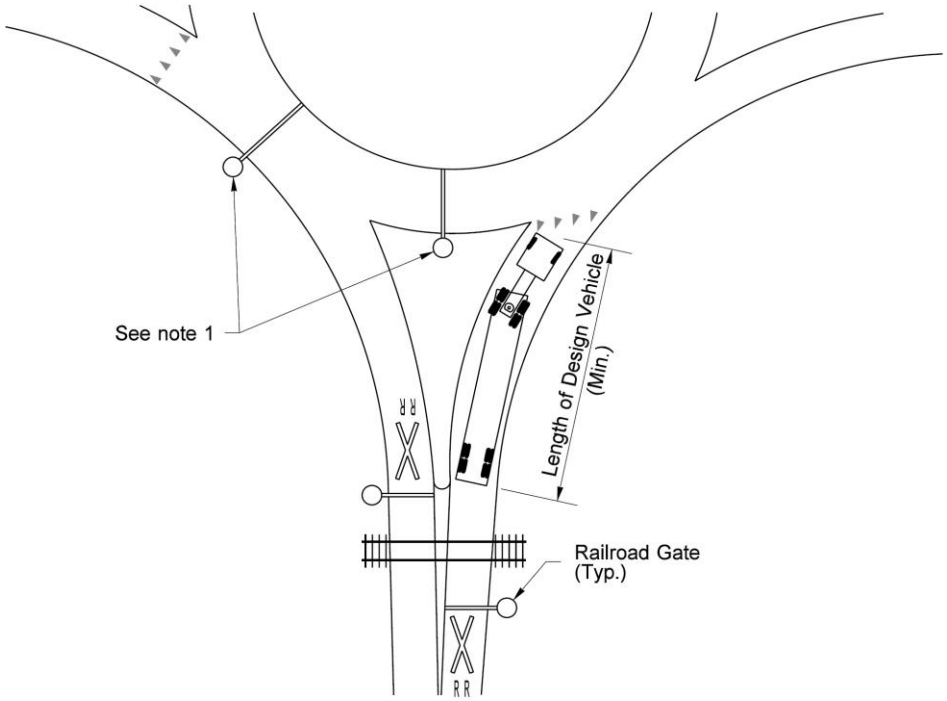



Acceptable Preferred Acceptable Preferred

**Add and Drop Lanes**
***Exhibit 1320-27***

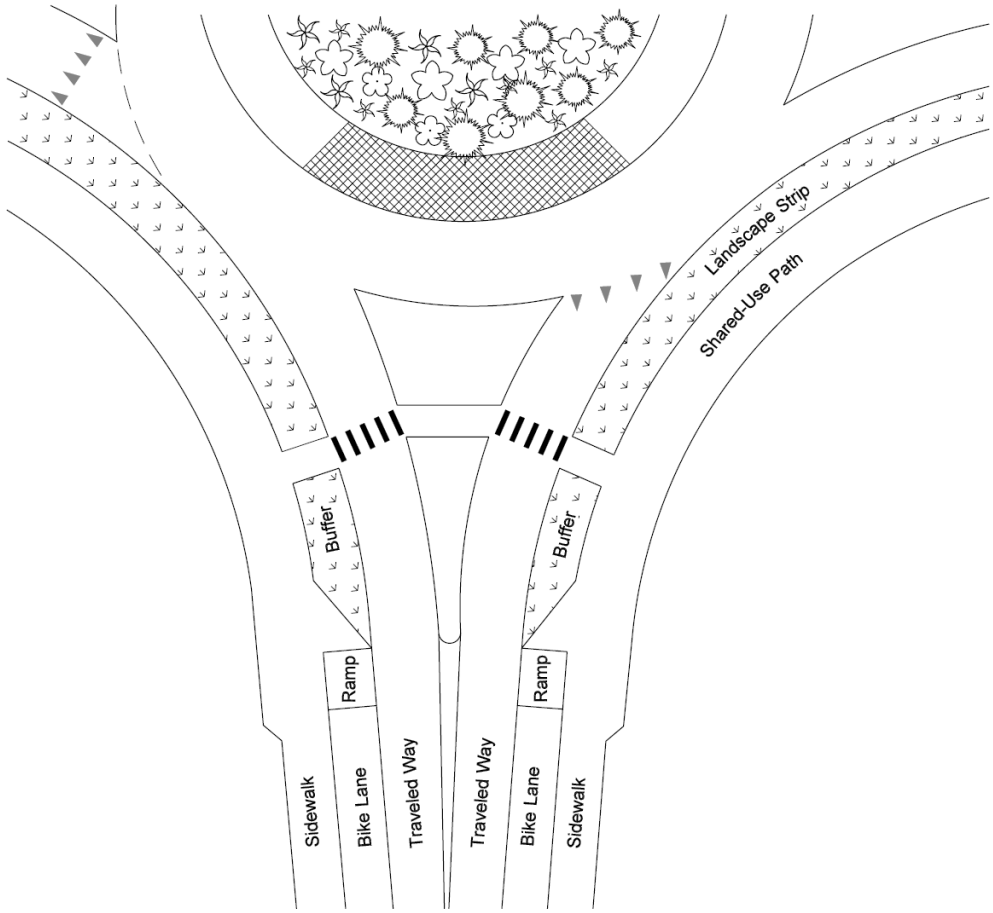
**Comment [PR69]:** (Consider using Exhibits 1310-12a, 1310-12b, and 1310-7 for determining minimum storage lengths when significant truck percentages are present. My concern is that 100-ft min may be too short for equal lane utilization)




**Note:**

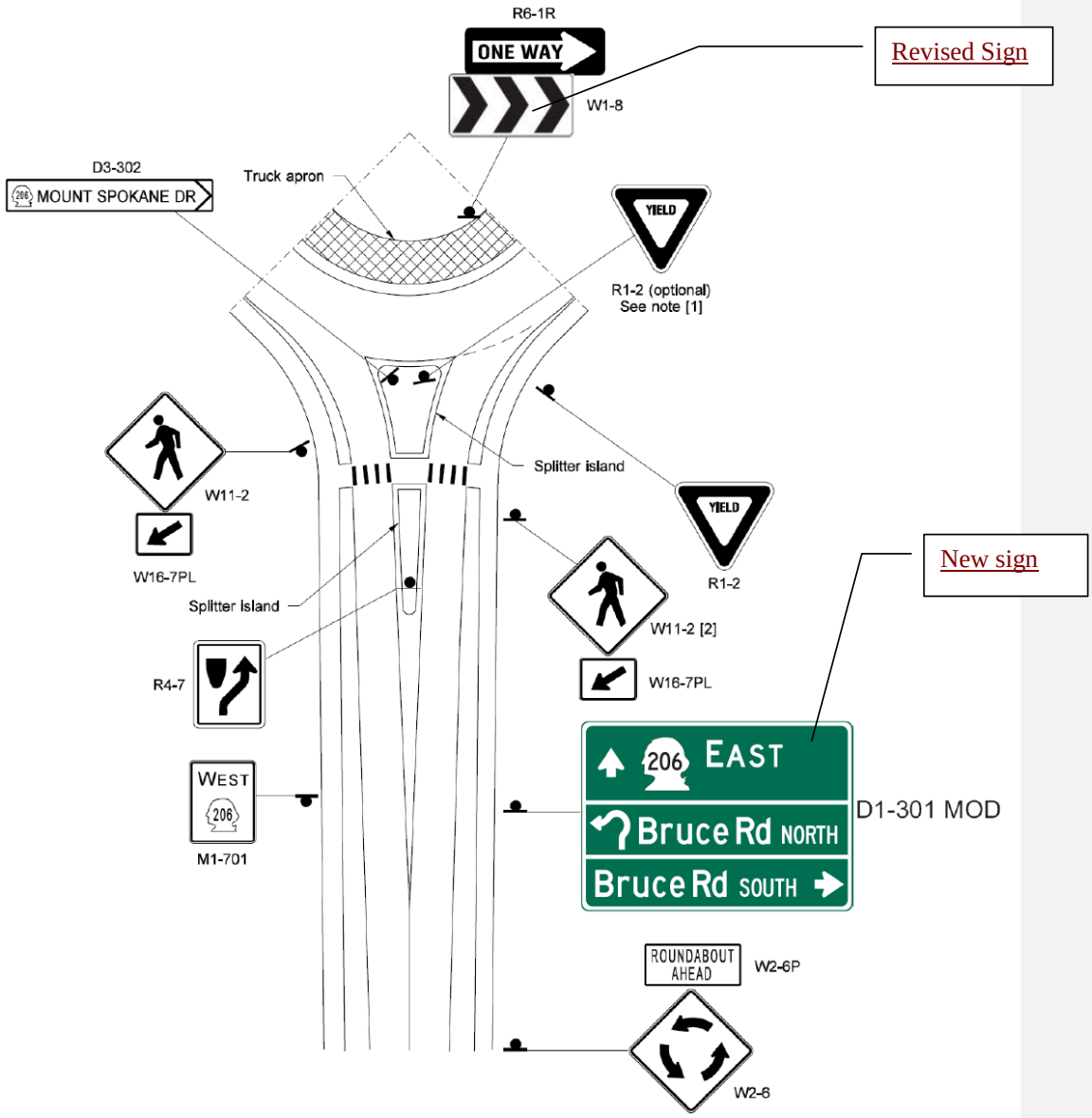
[1] Use the intersection analysis and site-specific conditions to help determine the need for, and optimum placement of, a gate on the circulating roadway (see **Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.**).

**Railroad Gate Configuration**
***Exhibit 1320-28***

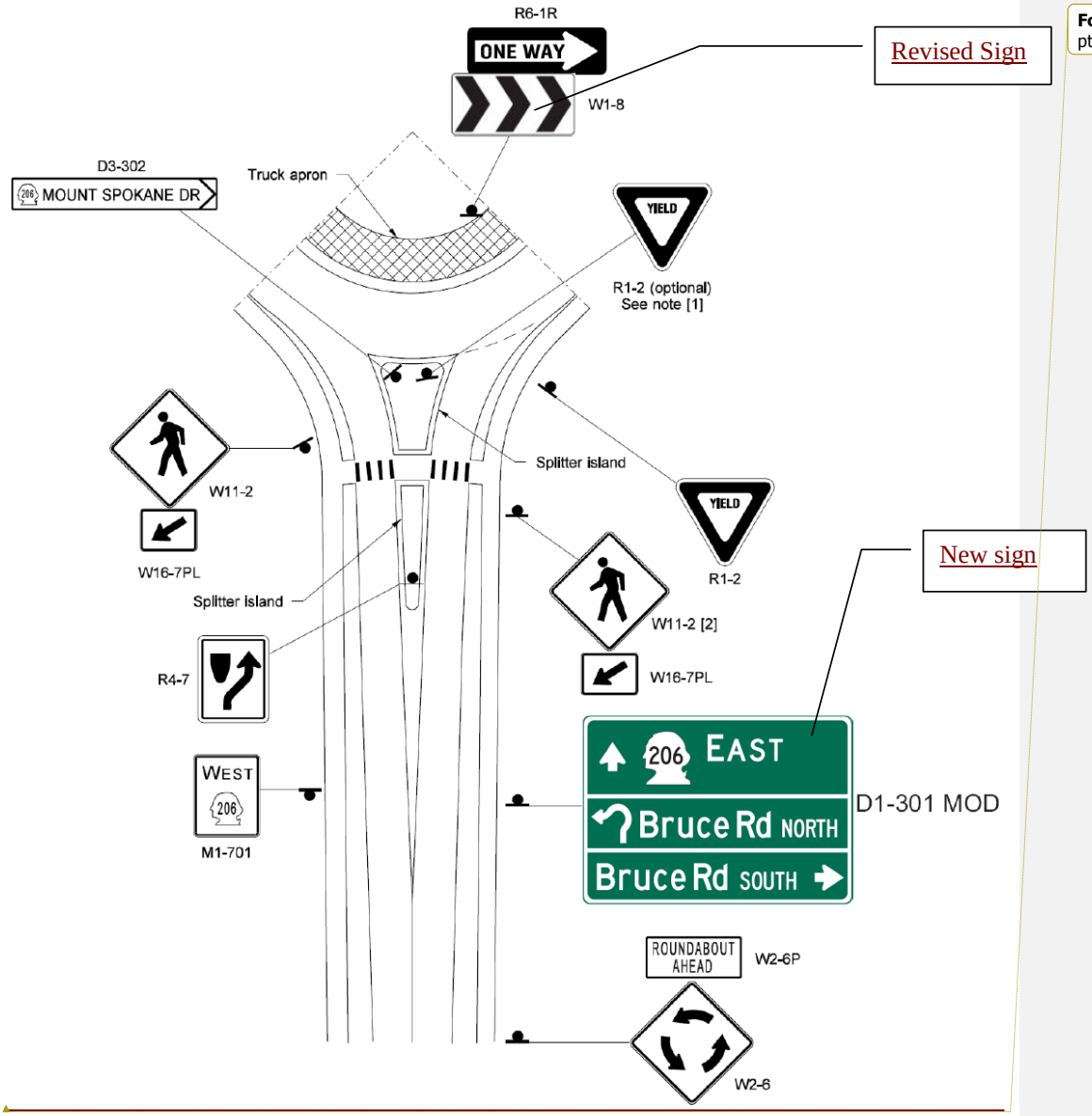



**Note:**
For pedestrian and bicycle design guidance, see Chapters 1510 and 1520 .

**Bicycle Lanes**
***Exhibit 1320-29***




**Roundabout Signing**
***Exhibit 1320-30***

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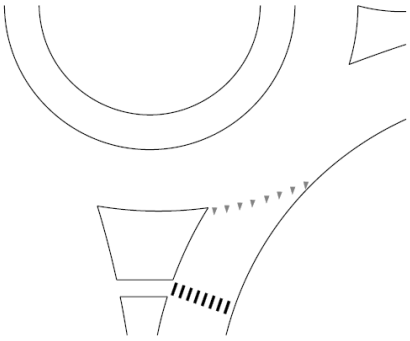
**Notes:**

[1] Provide on two-lane entries; consider when view of right side sign might become obstructed.

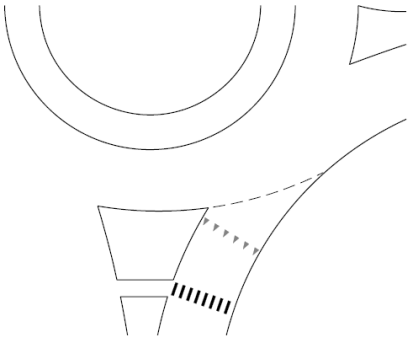
[2] Locate in such a way as to not obstruct view of yield sign.

**General:**

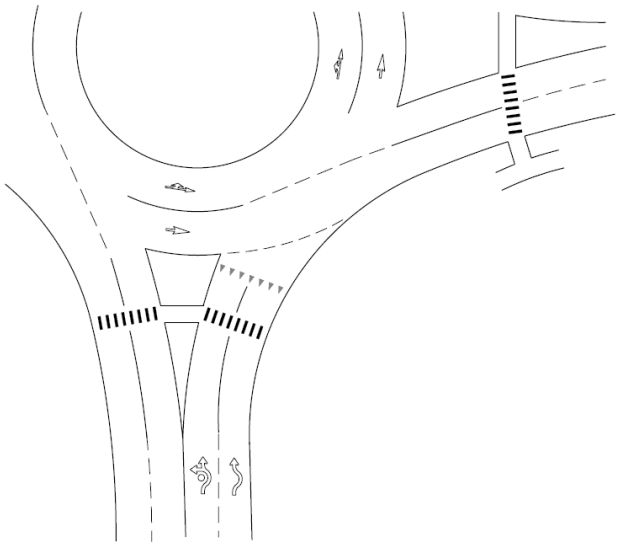
For additional information on sign installation, see Chapter 1020.



**Single-Lane Striping Option 1**



**Single-Lane Striping Option 2**



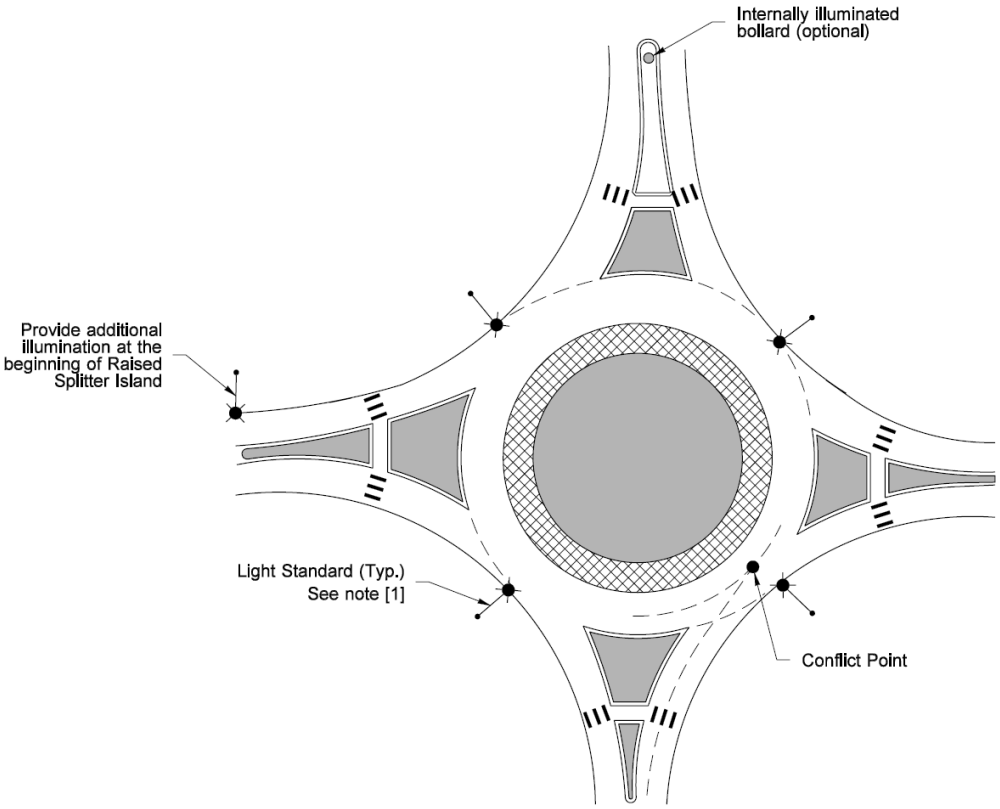
**Multilane Striping**

**Note:**

For Single and Multilane Roundabouts use Option 1 or Option 2 for placement of "yield symbols" at or near entry line.

**Comment [KS70]:** What is Ed Laugergin's recommendations?

**Roundabout Striping and Pavement Marking**
***Exhibit 1320-31***

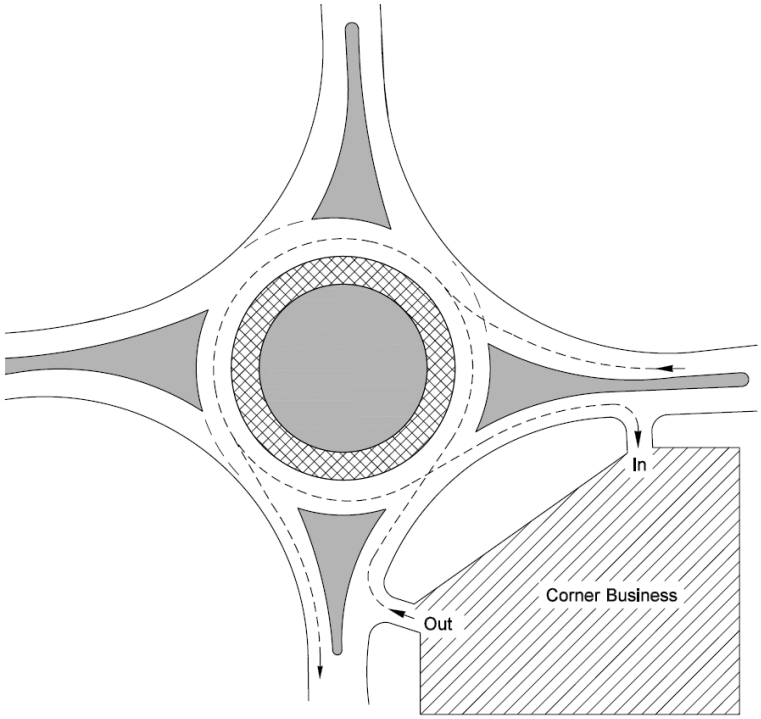



**Note:**

[1] Consider additional lighting for walkways and crosswalks to provide visibility for pedestrians. Also use to provide illumination of the roadway behind the pedestrian from the driver's perspective. from the driver's perspective.

**Comment [ORTraffic71]:** Refer reader to the illumination section in the design manual?

**Roundabout Illumination**
***Exhibit 1320-32***

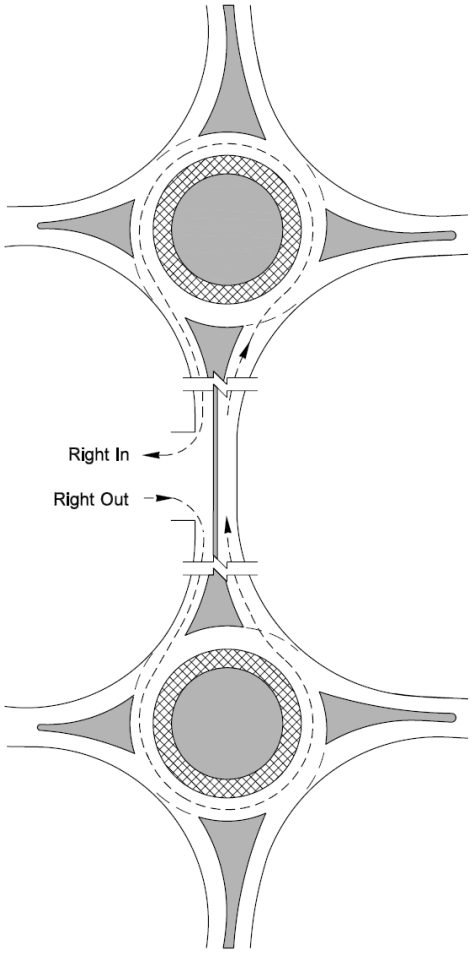



**Comment [W72]:** Show right- in movement on bottom access and right-out movement on top access

**Notes:**

- For additional restrictions on limited access highways, see Chapter 530.
- For corner clearance criteria on managed access highways, see Chapter 540.

**Multiple Access Circulation**
***Exhibit 1320-33a***




**Left-turn access between roundabouts using U-turns at the roundabouts.**

**Multiple Access Circulation**
***Exhibit 1320-33b***